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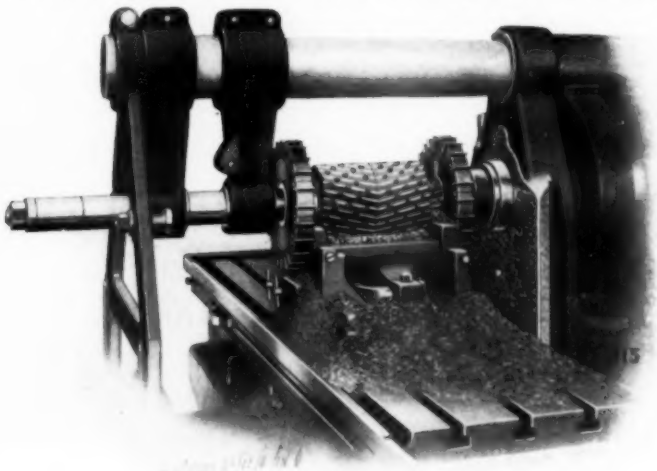
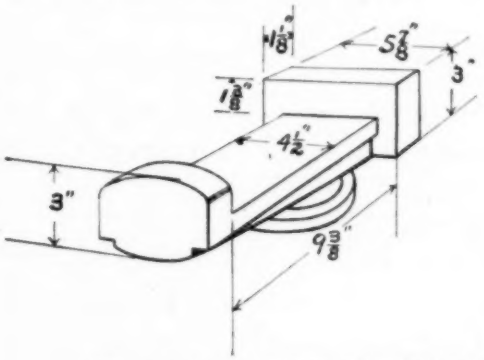
Index to Advertisers and Classified Index Following Reading Matter.

Milling Time 13½ Min. - Planing Time 33¾ Min.

These figures include chucking and handling.



The Planer carried two rows of pieces, used two heads, and took the roughing cut at 50 feet per minute.



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Removes 10 Gubic Inches of Metal Per Minute.

On such work the outer arbor bearing carries the same load as the main bearing. Note how we support it by bracing from the rigid box section knee and the large diameter overarm. The Motor Drive gives the machine its great power.

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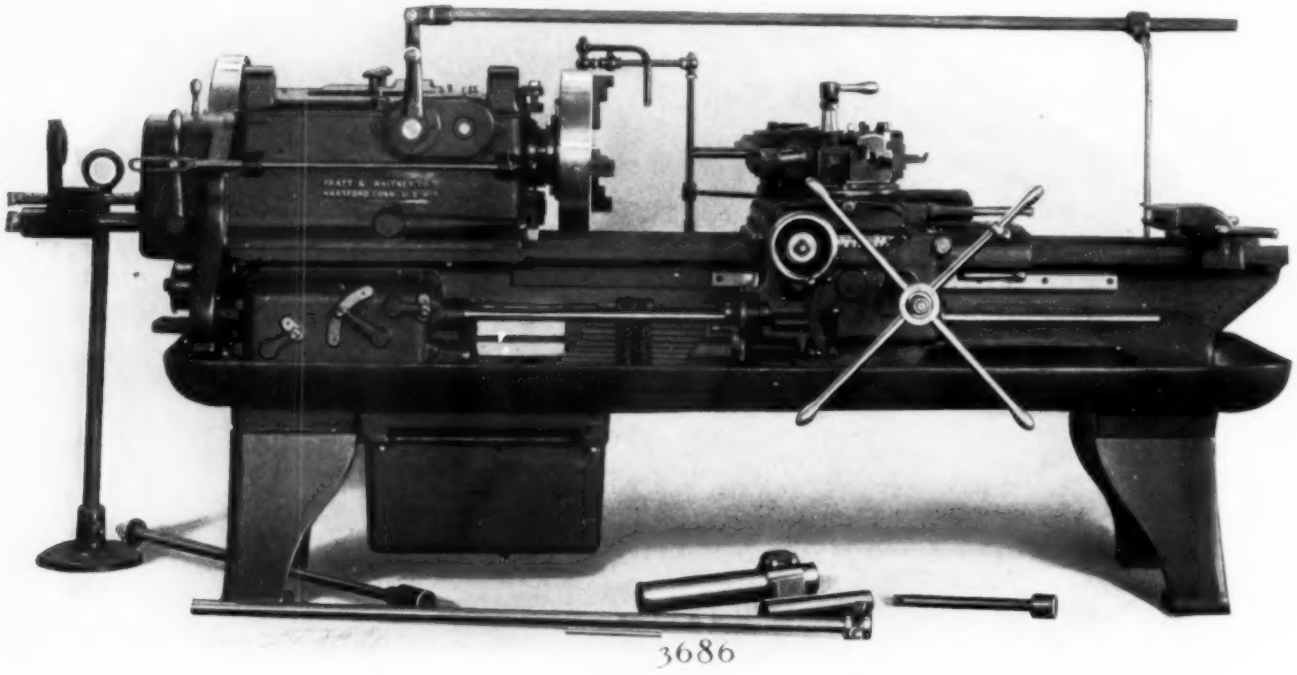

A 2½ x 26 Open Turret Lathe with Three-Jaw Chuck and Chucking Tools in position.

This machine has a stiff geared head which is stationary and is arranged for constant-speed drive either by a direct-connected motor bolted directly to the head or single pulley belted to countershaft.

Turret is mounted on a slide of generous proportions, and has both positive power and hand-feeds in longitudinal and transverse directions.

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The Design of an Automobile Steering Gear

How the Use of Well Tried Mechanisms, Careful Computations, Considerations of Wear and Positive Connections are Necessary

BY E. W. GRAHAM

The design of a steering gear for an automobile presents some interesting problems, besides being one of great importance as regards the easy and safe operation of the car. An accident to the steering gear may easily place the driver in serious danger. Therefore, the utmost attention should be given to all points in its design, that they may be suited to the service desired of them and properly proportioned for strength.

The first considerations are, the wheel base, the tread, and the distance apart of the centers of the steering knuckles. The wheel base depends upon the size of the car, the space occupied by the engine, and required for the passengers. Another consideration is, that, speaking in a general way, a car with long wheel base rides easier, particularly at high speed, than a car with a short one. However, a long car requires a wide street to turn in without backing, so the length should not be extreme. A long wheel base also means deep and heavy side rails, which may prove an objection. The tread of cars for general service is usually made standard or 56 inches center to center of wheels. In order to reduce the leverage of the forces acting on the front wheel, it is desirable to make the distance from center of wheel to center of steering knuckle as short as possible. Some designers have gone so far in this direction as to place this center within the hub of the wheel and lying in the plane of the wheel itself. This, however, seems a needless refinement, adding expense to construction as well as perhaps a certain unreliability of action, without any adequate advantage to warrant it.

In the design of any piece of mechan-

		Model		
		F	G	H
A	Wheel Base	127"	100"	127"
B	Tread	56"	56"	56"
C	" to C.L. of Car	28"	28"	28"
D	Width Front of Frame	31"	30"	31"
E	C.L. to C.L. of Knuckle	48 11/16"	48 11/16"	48 11/16"
F	Tire to Frame	1 3/8"	2 3/8"	1 3/8"
G	Dia., Front Tire	36"	32"	36"
H	Thickness Front Tire	4 3/8"	4"	4 3/8"
I	Dia. Rear Tire	36"	32"	36"
J	Thickness Rear Tire	5"	4"	5"
K	Extreme Angle of Turn	34	32	34
L	Length Steering Arm	5"	7"	5"
M	" Side Rod Arm	7"	7"	7"
N	Width Rear of Frame	34"	34"	34"

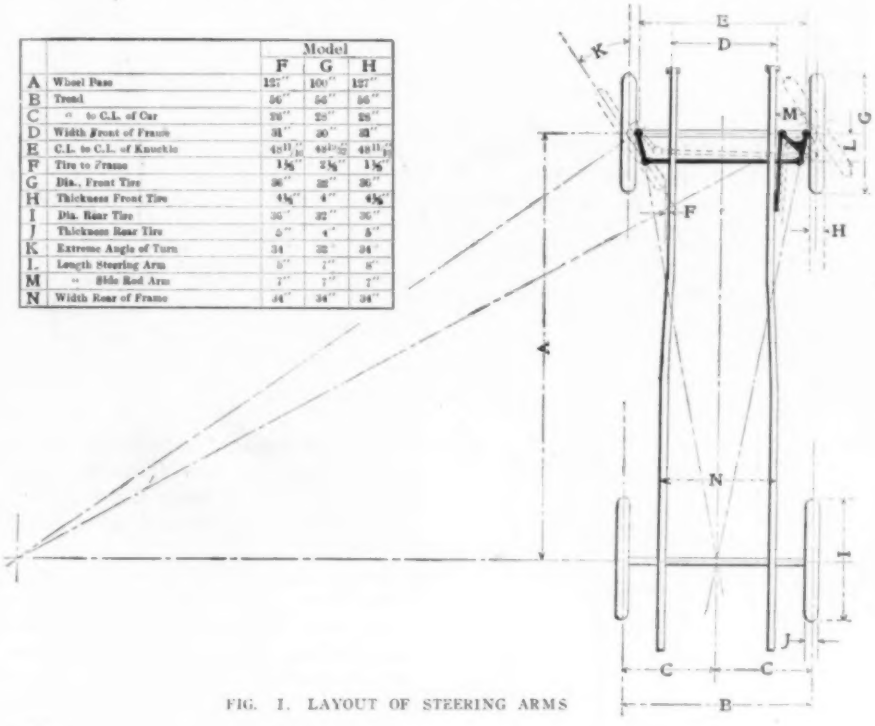
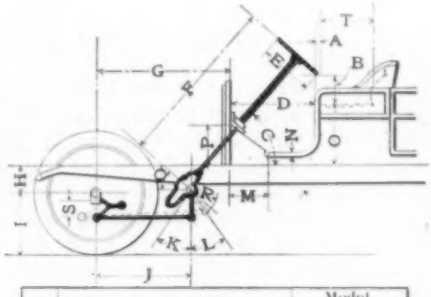


FIG. 1. LAYOUT OF STEERING ARMS



		Model		
		F	G	H
A	Front Cushion to Wheel	1 3/8"		1 3/8"
B	Top of " " "	3 1/8"		3 1/8"
C	Angle from Floor to Frame	41°		41°
D	Dash to Front Seat	23 5/8"		23 5/8"
E	O. Dia. of Steering Wheel	16"		16"
F	C.L. S.W. to C.L. Steering Gear	51 7/32"		51 7/32"
G	Dash to Front Axle	40"		40"
H	C.L. Wheel to Top of Frame	8"		8"
I	" " " Ground	15"		15"
J	Length S. Side Rod	29 1/2"		29 1/2"
K	Angle, Arm Ahead	34°		34°
L	" " Behind	34°		34°
M	Dash to Bottom Foot Board	12"		12"
N	Top Frame to Top Floor	3 3/4"		3 3/4"
O	" " " " Cushion	19 1/8"		19 1/8"
P	" " Top Foot Board	12"		12"
Q	" " C.L. S. Case	7 1/8"		7 1/8"
R	Length Steering Crank	8"		8"
S	C.L. Socket to Side Rod	4"		4"
T	Wheel to Cushion	15 1/8"		15 1/8"

FIG. 2. LAYOUT OF STEERING GEAR

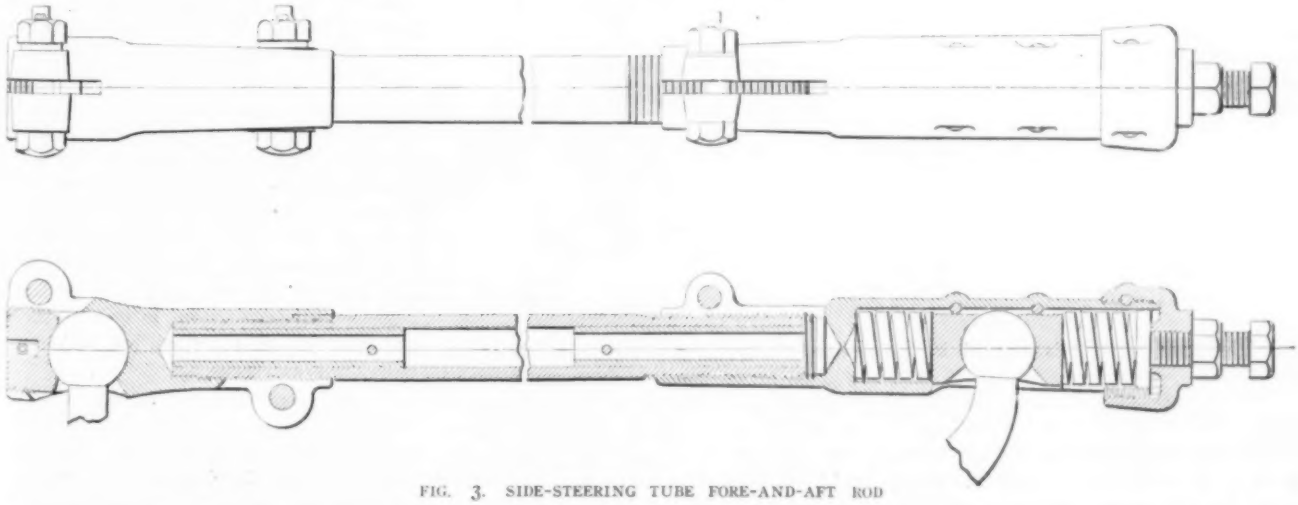


FIG. 3. SIDE-STEERING TUBE FORE-AND-AFT ROD

ism, the successful engineer will always consider reliability first. The most successful designers have built up their reputation, and made their companies rich, by adhering closely to well tried and tested devices and adopting new devices rather slowly. Right here might be written a book on design. Everyone who has been through the mill recognizes that there are several ways of solving a given problem;

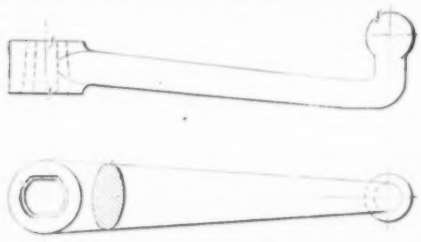


FIG. 4. STEERING CRANK

all of them correct in that they accomplish the result. You may be sure, however, that all of these methods are probably wrong in the opinion of someone else. It is evidently not practical to design anything so perfectly that it cannot be found fault with, and the designer must stop somewhere in the refining process. It is more creditable to the designer to get out something which will be wrong any way, than to spend so much time in refining that he fails to get results. "Get there,"

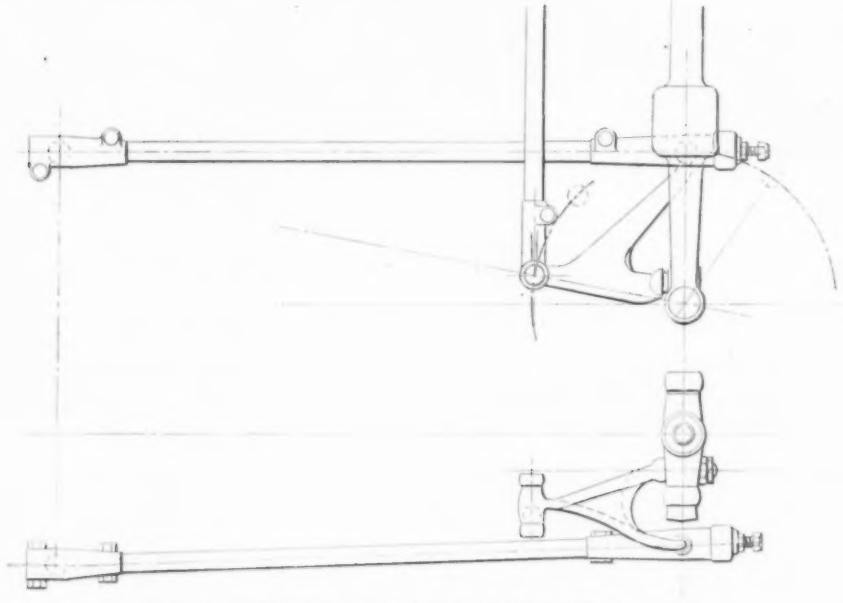


FIG. 5. ARRANGEMENT OF STEERING KNUCKLE AND TUBE

and "get there quick," is wanted in the auto business to-day.

Elements of the Design

Knowing that our design will be "wrong anyway" to some, let us not get lost in a maze but set about getting results. In case of question always incline to the safe policy of combining well tried and tested devices, rather than to adopt an ingenious device simply because of its ingenuity. It is evident that in rounding a curve, the line of the axle of the steering wheels produced should intersect that of the real axle produced; thus all wheels turn from a common center. The differential allows the rear wheels to rotate at the different speeds necessitated by turning. By having the front wheels inclined, as stated above, they will run around on the curve without the side slip, which is so very destructive to the tire. Designers wish to know actual dimensions for certain conditions, and I show here two diagrams, a plan, Fig. 1, and elevation, Fig. 2, which show some of the points to be considered, as well as proportions. The common tread of large cars is 56 inches, center to center of wheels, which allows the car to run in the ruts left in a road by horse-drawn vehicles, as well as running in the tracks of street railways.

The steering knuckles of the front wheels have arms attached to them by which they are turned. These arms are connected by a cross-rod which may be either in front of the axle or at the rear. Either method will give good results if properly constructed. There are good arguments for placing it in either position. The rod in front of the axle is under tension for most of the road shocks, and gives better action of the wheels, as regards side slipping, over a greater angular range than in the rear. If the wheel is run into the curbing, or a similar obstruction at the side of the wheel, with the cross-rod in front, the rod is placed under compression and may bend, or even be broken. The rod in front is more

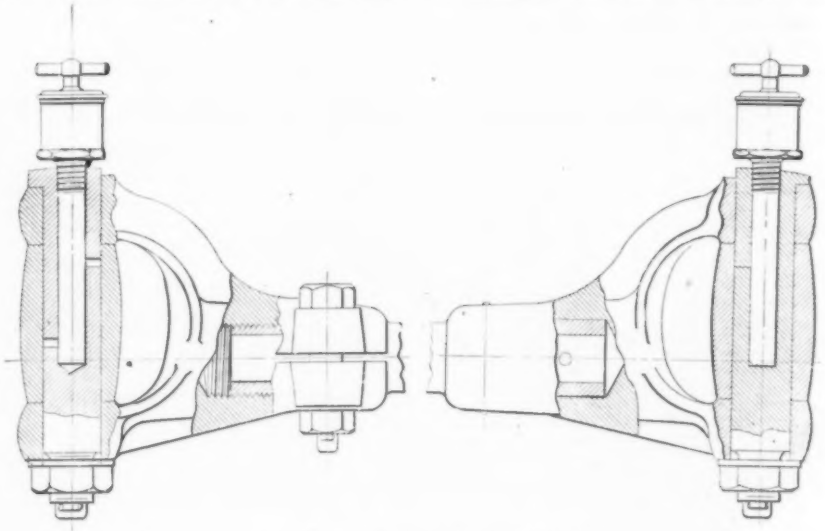


FIG. 6. THE CROSS-STEERING TUBE

likely to be damaged by running into an object. Many an auto driver has come to grief by running into a dog and bending or breaking a cross-rod, when it was in front of the axle.

The steering knuckle arms have to be spread apart, if in front, and converge if in the rear. Sometimes there is too little room between the spokes of the wheel and the steering knuckle arm to use an arm of sufficient length without interfering with the spokes, if the cross-rod is in front. The rod in front may necessitate an awkward starting crank of ungainly length to avoid interference when cranking the engine.

The cross-steering rod at the rear is well protected, as it is back of the axle. There is more room for the connections between the ends of the levers and spokes and will give good satisfaction if properly proportioned. Either method will give good results and good cars are built both ways. Its location is one of those questions not fully settled, but subject to individual preference.

As the front wheels turn through different angles in rounding corners, some method must be adopted to cause the wheels to take the different positions necessitated by the conditions imposed. It is evident, from a little thought, that a lever at right angles to the axle will not answer, as then the wheels would turn through equal angles and remain parallel to one another, with consequent side slipping of the tire. About the first thing that

will occur to the designer is to incline these arms away from a position at right angles to the axle. By laying out to a large scale on the drawing board the different angles of the inner wheel, the corresponding angle of the other wheel is found by meeting the above stated conditions—that is, the axles produced must meet in the same point on the line of the

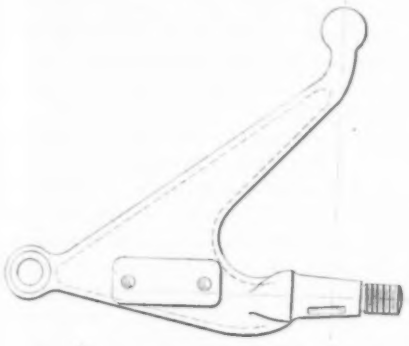


FIG. 8. RIGHT-HAND STEERING ARM

rear axle produced. Then, with a length representing the cross-rod, the corresponding positions of knuckle arms may be found. There is no one angle of steering arms exactly right for all angles of steering wheels, but by using some judgment an angle may be found which is close enough for practical purposes.

In this connection consider how the car is to be used. In ordinary running the wheels are moved only slightly from side to side in order to pass objects on the road; occasionally a corner is turned. The maximum angle will usually be found to be not over 30 degrees and the usual angle required is far below this. The maximum angle which it is desirable to use to turn the front wheels is 34 to 35 degrees on each side of the straight-ahead position. A greater angle than this places too great a side strain on the steering wheels and often becomes dangerous, as the parts are likely to lock. The usual conditions are well met by causing the steering-knuckle arms, when produced, to meet at the center of the rear axle.

If the car is to be used on a race track, then the front wheels will be inclined most of the time and the angle at which they are to be turned should be considered when laying out the steering-knuckle arms, in order to prevent side slipping of the tire, an especially bad feature with a racing car. The reason why inclining the levers compensates for the different angles required to turn the wheels is easily seen when laid out on a drawing board. The effective length of the arm is given by the length of a line through the steering-knuckle center, drawn at right angles to the cross-rod, produced if necessary. It will be seen that as one lever increases in length, the other shortens or reduces its effective length. The angle for the levers may be calculated for one set of conditions and a series of calculations may be made for different positions of the steering wheels. The result is generally more quickly obtained by a graphical solution. The rule should always be adopted of choosing that method which gives a result in the minimum time with the least amount of labor. Keep constantly in mind that the management dislikes to pay for frills and refinements. The proper angle of steering tube for appearance and the location of steering wheel for convenience will determine the dimensions given in the elevation diagram, Fig. 2.

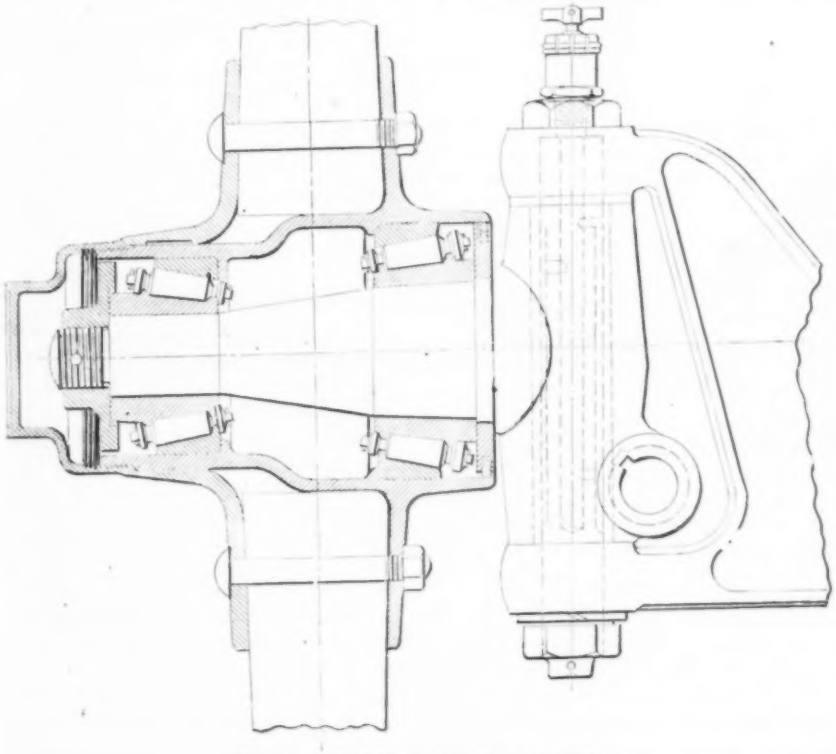


FIG. 7. STEERING KNUCKLE AND HUB

The Fore and Aft Rod

The connection from the steering-case arm to the steering knuckle lever is by the side rod or fore and aft rod. It is desirable to keep the steering crank and

FIG. 9. LEFT-HAND STEERING ARM

steering-knuckle lever of the same length, as then the angular motion of each is the same and the pressure on the joint is equally divided. These motions should be carefully plotted. The total movement is given by the length of a line joining the two positions, not by the angular movement. The fore and aft rod should be horizontal at mid-position. In order to provide for the motion up and down of the car, as well as that due to moving the wheels, the fore and aft rod needs to be connected to the levers by ball and socket joints. If all these connections are rigid, the shock of driving localizes the strain on the steering crank and steering arms at the neck joining the ball, and they are likely to break off at that point, also the steering of the car is hard. This difficulty is overcome by a spring buffer connection in one end of the fore and aft rod.

The shock given to the steering connections by obstructions on the road is transmitted through the spring buffer and is gradually transmitted to the steering crank. This lessens the liability of breaking off the ball on the steering crank, as well as the shocks transmitted through the steering wheel. The principle of this is illustrated by the spring used between the traces and whiffletree of a horse-drawn heavy vehicle. With these springs a pair of horses will start a heavy load which would break the trace without them. The inertia of the load is gradually instead of suddenly overcome. This spring buffer side steering rod is well shown by Fig. 3. It will be seen to be provided with screws at both ends for taking up looseness whenever it occurs. It is essential that lost motion be taken up at all points of the steering mechanism, as any looseness becomes dangerous when a car is run at a high speed. A slight looseness of joints, or movement of hand wheel, which would give a gentle swing at slow speeds, would wrench the car at a high speed. The fore and aft rod is made adjustable for length as shown, to properly adjust the parts when in place on the machine.

The Steering Crank

The attachment of the steering crank to the shaft is of the greatest importance.

This is shown by Fig. 4. There are several ways which are reliable, subject in a general way to individual preference. The point to make sure of is, that the crank is in intimate contact, metal to metal, with the shaft, before any clamping or locking device is added, and that the clamping or locking does not disturb this intimate and perfect fit. One good way is to broach the crank with a square hole and mill the shaft carefully, say, 0.002 to 0.003 inch large, and press them together. Another modification is made by adding a clamping screw and splitting the crank on the back. In this case the crank must press on snug with, say, a 0.001-inch press fit, before being clamped, and the clamping arranged so that it does not spring the parts away when tightened.

Another method sometimes adopted is a taper, fitting a corresponding taper in the crank. The taper has flats made on each side which fit corresponding surfaces in the crank. This requires a fine broaching operation on the cranks and the best of workmanship, but gives good results when well fitted.

Other methods will suggest themselves. The parts must be in intimate contact and held from lost motion or they will rapidly work loose. Keys are not a success; the parts must be held from turning by their form and not depend on keys, which are difficult to fit.

Fig. 5 shows the relation between the fore and aft rod, the right steering knuckle and the cross steering rod. The cross steering rod in this case is behind the front axle.

The cross steering connection, Fig. 6, shows a good way of connecting across, using straight hardened pins for the bearings and lubricating by means of grease cups. One end of the rod is pinned and brazed, the other threaded into the fitting by means of which adjustments as fine as one turn may be made, to compensate for the steering levers getting slightly bent. After adjusting, it is clamped tight by a clamp bolt. All bolts and nuts about an automobile must be locked in some manner, the common method being a lock washer and cotter pin as shown.

Fig. 7 shows the right steering knuckle and wheel hub, showing how the steering lever fastens to the steering knuckle, by means of a taper fit, and is prevented from turning by a key. It is drawn into place by a nut. The fit is long and large. The right and left steering arms are shown by Figs. 8 and 9. These are both crooked pieces, giving considerable trouble in designing to get parts so related that there is no interference from the axle, or from the cross steering rod, when these arms are swung to their limit in both directions. It will be noticed that the ball to which the fore and aft rod is connected, has a drop sufficient to allow the rod to pass freely under the front axle. The bars for the cross steering rod are long, to allow the use of a straight pin, having sufficient bearing to give long wear. The design of the steering arms is very important. They must be strong and still allow ample clearance between the parts to allow for the whole sweep of wheels from one extreme to the other.

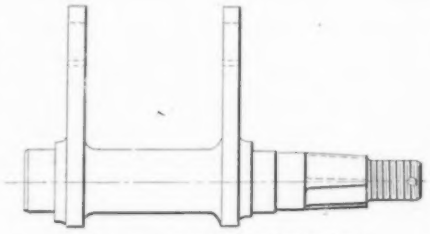


FIG. 11. STEERING-CASE YOKE

The Steering Post

We now come to the steering post itself, containing the mechanism by which the steering lever is made to move back and forth. The steering lever is rigidly fastened to a shaft passing through the steering case, and usually carried on either roller or ball bearings, although it may be supported in plain bearings. Attached to this shaft, usually forged solid with it, is a worm wheel, a spur gear, or lever, engaging with some device causing it to move back and forth through a limited arc, and carrying with it the steering lever referred to.

There are various methods of accomplishing this end, each having its advantages and disadvantages. With most of these devices, the wear is unequal. The car is driven most of the time straight ahead with but slight changes in direction. This results in the wear of the parts taking place over only a small section.

With the worm and segment gear this causes looseness in the steering connections. If an attempt is made to take up this wear by moving the segment into closer mesh, we find a tight spot, which may prevent turning the worm past that point. The intention of the designer is to cause wear to be uniform over all the parts, so that if any method of take-up is introduced it will adjust at all parts. If the wear is unequal it becomes difficult, if not even impossible, to adjust to offset the wear in one place without causing the parts to operate with too much friction at other portions.

With the difficulties above mentioned in mind, considerable attention has been given of late to the quick-pitch screw and nut, of which type Fig. 10 is an example. This steering gear will repay careful study, for, while it is far from perfect.

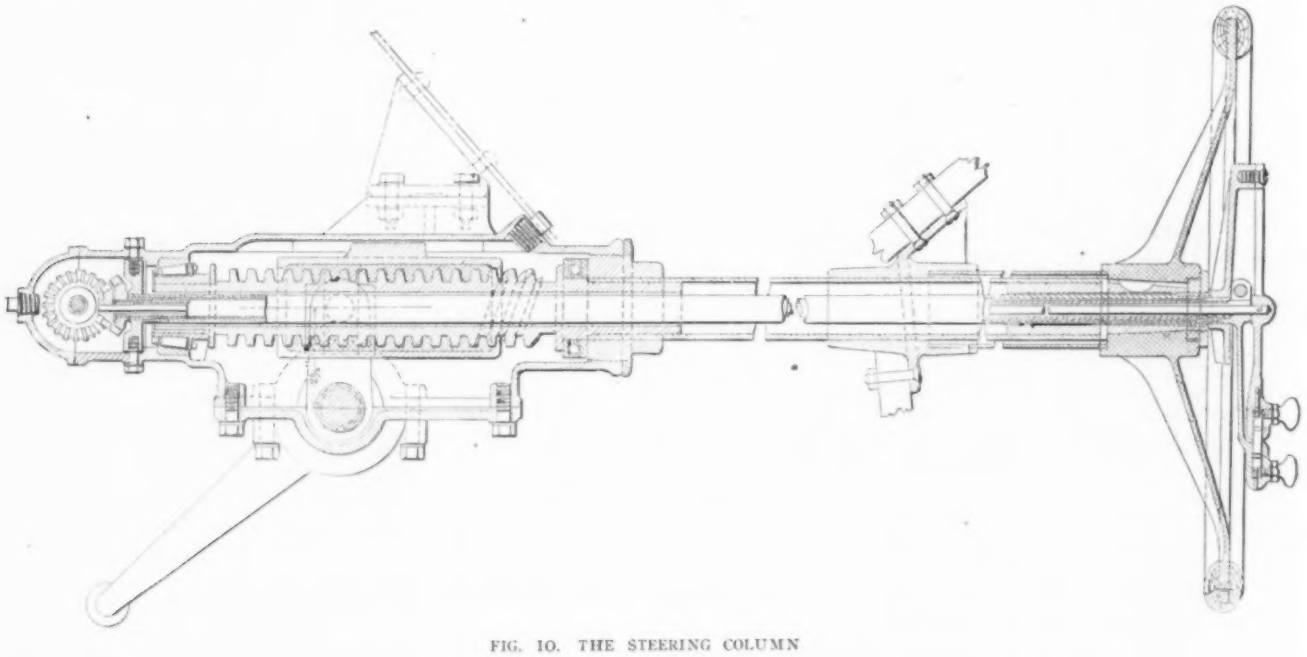


FIG. 10. THE STEERING COLUMN

there are some very good features. The space in which this gear had to be placed necessitated a proportion for some of the parts different from what would have been chosen otherwise.

The steering yoke, shown by Fig. 11, has two trunnions working in the holes in end of the arms. These trunnions slide in grooves across the steering-nut case. The case is prevented from rotating by a projection on one side sliding in a groove in the outer case of the gear. The case is placed about the screw and babbitt poured around it; thus the nut is easily made. Within this turns the screw, and what would be ordinarily a tedious and expensive job is easily accomplished.

There is no adjustment to the parts of this gear, the idea being that the parts are so liberal in wearing surface that what little wear occurs will not give objectionable looseness for a long period of use, and the life of these parts will probably exceed that of other vital parts of the car. Take up, in a case of this kind, either by splitting the case and clamping together or adjusting by drawing the nut together or separating the parts in the direction of its length only localizes the wear and is only temporary. The adjustment is quickly lost. The case is filled with a thin grease in order to lubricate all the wearing surfaces.

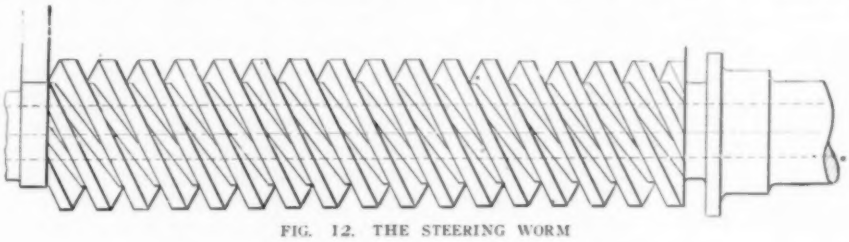


FIG. 12. THE STEERING WORM

The screw, Fig. 12, is a two-inch lead quadruple Acme thread of half-inch pitch. The movement of the steering wheel required to throw the wheels from one extreme to the other is one and one-half turns, or 68 degrees of motion of the front wheels. The designation above, of course, means that the nut advances two inches for one turn, and that the individual teeth of the thread are one-half inch center to center, giving a tooth one-quarter inch thick at the pitch line and with sides at an angle of 14½ degrees with the vertical, or 29 degrees included angle.

Proper steering is associated with the control of the speed of the car by means of the spark and throttle control on the steering wheel. The method of doing this is shown by the lower portion of the steering column, Fig. 10. There are two shafts carrying bevel gears; one shaft is a tube, with the other running inside it to give ample bearing. These shafts carry short levers, as shown; the longer is connected by a link to a butterfly valve in the supply pipe from the carbureter and controls the flow of gas to the engine. The short lever is connected by a link to the magneto or distributor which controls the time of the spark.

These gears are operated by bevel gears on the end of shafts extending up through the steering column to levers at the wheel, which move over notched quadrants. By the movement of these levers the speed of the car is controlled. The quadrant remains stationary while the steering wheel is operated. There is a support for the upper portion of the steering column, and from this extends a stationary outer casing for the column.

This column conforms to modern ideas as to what is desired. Some of the details might be changed to make it more compact, also stops could be added to adjust the throw of the steering arm. The fastening to the car is by a bracket on one side to the sub-frame, and by a loose piece clamping to the steering gear and side rail of the car on the other side. Much of the above explanation is incomplete, as a certain familiarity with the subject is assumed to be possessed by the reader.

In figuring the travel of the parts, take into consideration that while the parts may move through the arc of a circle, it is the straight line joining these parts which gives the actual extent of motion. The motions should be carefully plotted and checked by calculation. There is opportunity for much ingenuity in designing a steering gear.

One should keep well in mind, however, that it is better to build up the gear out of details whose principle has been demonstrated to be correct in other lines. There are altogether too many freakish things at present which enter into automobile design. It is some of these freaks which make the repairs of automobiles so expensive. There is ample opportunity for the engineer in automobile design and managers are coming to recognize this more and more every year.

The cotton-mill industry of the South which has shown such phenomenal growth in the past decade owes no small portion of its success to the use of electricity to drive its looms and spindles. The advantages of this method over the older line shaft and belting are well known, resulting in saving the first cost of shafting, frictional losses, saving of power, labor and oil and the possibility of easily securing a clean well lighted mill, which insures the better health of operatives.

Ice Difficulties with Hydraulic Power Installations in Cold Climates

Persons in temperate climates have little idea of the difficulties which beset the working of hydraulic power plants in countries where the temperature in winter often falls much below zero on the Fahrenheit scale. Some of these were related by Prof. H. T. Barnes, B. Sc., in a paper before Section G at the recent meeting of the British Association, who described the conditions met during the winter months in Canada, when ice is forming rapidly, and ice-bridges, dams, and shoves sometimes change the whole character of the levels and channels in a single night. The steadiness of the temperature of the water throughout the ice season is a matter of great interest. It seldom varies more than a few thousandths of a degree from the freezing point even in the severest weather. Spicular ice, or, as it is called in Canada, frazil ice, is formed by surface agitation in the more turbulent rivers, and in waterfalls, and accumulates in great quantities in the quieter portions of the stream, where it is carried by currents. It varies in size from thin plates to fine needle crystals, depending on the degree of agitation of the water, and of all the forms of ice it gives the most trouble in hydraulic work. During severe cold weather the water is thrown into a slightly supercooled state, during which time the ice crystals grow rapidly by continued freezing, and give rise to the agglomerating stage, when they possess adhesive properties and form lumps and spongy masses. In this condition the ice is dreaded by power users, for it quickly adheres to the rack bars and to the machinery of the wheel-gates and turbines. In a short time it interferes with the operation of the wheels, and may, at any moment cause a temporary cessation of operations. Fortunately, it is only a minute temperature depression which brings about these conditions, and methods of artificial heat applied about the affected spots relieve the situation in a short time. An intelligent use of artificial heat, specially at night time, when supercooling is most common, is found valuable in preventing any interference with the normal operation of a power-house. It is not necessary to warm the entire volume of water passing through, which would be very costly and difficult, but by applying the heat in the racks or wheel cases, or blowing steam about the affected parts, the ice is prevented from obtaining a foothold. It is well known that the most effective prevention to the formation of both frazil and anchor ice is the protection afforded by a surface sheet of ice. If a power-house is located on a river normally frozen over, with no stretches of open water above, no ice troubles are experienced.—*Mechanical Engineer.*

The Camming of Automatic Screw Machines—II*

How the Changeable Pulleys and Gears Affect the Tool Feeds and the Two-speed Spindle Drive Modifies the Cam Angles

BY C. L. GOODRICH‡ AND F. A. STANLEY†

In the first section of this article methods were presented for determining the cam angles of the Pratt & Whitney automatic to give the cutting tools the desired rates of feed per revolution of spindle and work. It was there shown that after subtracting from the circumference of the turret-slide drum the peripheral space occupied by the 50-degree, or non-cutting and non-indexing cams, the eight cam roll spaces and the eight ¼-inch flats on the cam ends, we had left a certain distance available for the cutting and indexing cams whose angles had to be figured or obtained by lay-out and measurement. We found, too, that during the rotation of the drum through a certain distance equal to the space occupied by these cams, the spindle should make a certain number of revolutions (as per Table 2 of the preceding section), determined by adding up the number of turns necessary for taking the different turret-tool cuts at the desired rates of speed, plus the turns during the indexing movements. In order, therefore, that the spindle and cam drum shall be driven at the proper relative speeds, with any given ratio of gearing in the feed motion, the question of the relative diameters of the spindle-driving drum on the countershaft and the feed-motion driving pulley on the same counter has to be taken into consideration. For it is obvious that, both spindle and feed motion being belted from the one countershaft, if we are using say a certain diameter of counter drum for driving the spindle, any change in the size of pulley for driving the feed motion will affect the rate of turret-slide feed per revolution of spindle.

Spindle and Feed-drive Ratios

In Fig. 16 is shown by diagram the arrangement of pulleys on countershaft, spindle and feed motion, *A* being the drum for driving the spindle in either direction through reversing belts running on spindle pulley *B*, which is located between two loose pulleys; *C* is the countershaft pulley (known as the "feed pulley") for driving the cam drum shaft *D* through pulley *E*, which operates the worm shaft and worm gear *F* at slow speed through the planetary gearing indicated at *G* or directly at high speed by a clutch connecting the pulley directly to the worm shaft. On the No. 1 machine, for example, the spindle pulley *B* has a diameter of 6⅝ inches, and the feed-motion pulley *E* is 6 inches. The worm gear has 84 teeth meshing with a triple thread worm and 28 turns of the worm shaft are required to drive the cam shaft and cam drums through one complete revolution. With a 24 to 1 ratio of gearing in the feed drive at *G*, it is obvious that the pulley *E* must turn 24×28 times, or 672 turns to each revolution of the drum shaft—assuming, of course, that the slow motion (24 to 1) is in operation throughout the complete cycle. The circumference of the turret-slide drum *H* carried by the latter being 48 inches, for each inch of peripheral travel of the drum, the pulley *E* on the

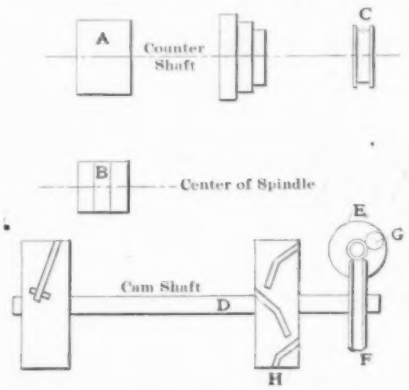


FIG. 16. DIAGRAM OF SPINDLE AND CAM SHAFT DRIVE

feed drive must turn $(672 \div 48) = 14$ revolutions. If we have (as found in connection with Table 2) a peripheral distance of 25.39 inches to travel during 521 turns of the spindle in order to give the required feeds with the cams, as figured out in the preceding article, the spindle must make 20.5 revolutions for each inch of drum travel. That is, while pulley *E*, Fig. 16, is making 14 revolutions, pulley *B* must make 20.5 revolutions. If the two pulleys were of the same diameter, the diameter of the countershaft drum *A* and feed pulley *C* would of course be in the ratio of 20.5 to 14 or 1.46 to 1. The spindle pulley, however, is 6⅝ inches diameter and the worm-shaft pulley *E* 6 inches; therefore the countershaft pulleys will be in the ratio of $(20.5 \times 6\frac{5}{8})$ to $(14 \times 6) =$ 136 to 84, or a ratio of 1.62 to 1. This ratio will be approximated very closely by a spindle-driving drum of a diameter of 10 inches and a feed pulley of 6 inches.

The foregoing matter has been presented in order to show the relation existing between the speed of the spindle and the speed of the cam drum drive. In practice, the diameter of the feed pulley required to be used in conjunction with any given diameter of driving drum for the spindle may be more directly obtained by the aid of a simple table—like Table 4 herewith. After we have found our cam angles as described in the other section, we may take the angle of any one of the cutting cams and use this in connection with our table for finding the required size of feed pulley.

Use of the Table

This table is arranged with columns for each feed-motion ratio from 24 to 1 down to 2.7 to 1. The quantities in these columns are obtained by dividing the tangent of the angles from 1 to 60 degrees in the second column by the feed-pulley constants 12.7, 5.91, etc., given at the heads of the respective columns. The feed-pulley constant, it should be noted, is equivalent to the number of revolutions of the head spindle to each inch of peripheral travel of the turret drum, with the same diameter of pulleys on the counter for driving the spindle and the feed mechanism. As indicated by the formula at the bottom of the table, the feed per revolution =

$$\frac{\textit{tan. of angle}}{\textit{feed-pulley constant}} \times \frac{\textit{feed pulley}}{\textit{counter drum}}$$

and as the six columns under the respective ratios are already worked out giving the equivalent of

$$\frac{\textit{tan. of angle}}{\textit{feed-pulley constant}}$$

the feed per revolution for any cam angle with any given ratio of gearing in the feed motion is found by multiplying the quantity opposite the angle and in the required column, by the feed-pulley diameter and then dividing by the diameter of the counter drum driving the head spindle.

Now, with a given diameter of counter drum for the spindle, and with the angle determined for any cam and the rate of feed given which we wish to produce with that cam, we can find the diameter of feed pulley required to produce that rate of feed by a formula as follows: *Dia. feed pulley = feed per rev. × dia. counter drum* $\div \left(\frac{\textit{tan. of angle}}{\textit{feed-pulley constant}} \right)$. As we have the expression $\frac{\textit{tan. of angle}}{\textit{feed-pulley constant}}$ already worked out in the table for the various angles, it is merely necessary to multiply the feed per revolution by the diameter of the drum for driving the spindle, and divide by the quantity opposite the cam angle under the proper

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column. Thus, if one of the cams in the set which we have figured as in the preceding article is to give a rate of feed of 0.005 inch per turn of spindle (using the 24 to 1 ratio), the cam angle being practically 6 degrees, and if we are using a 10-inch drum on the countershaft for driving the spindle, we can find the size of the feed pulley required by multiplying 0.005 × 10 = 0.05 and dividing by 0.00827 (found opposite 6 degrees and in the 24 to 1 ratio column) = 6. Hence a 6-inch pulley is the proper size to use. It will be obvious that owing to the method used in determining the angles of the set of cams for the turret-slide drum, it makes no difference whatsoever which cam is used as a basis for working out the feed-pulley diameter.

Similar tables may be figured for the other sizes of machines and will be found of considerable value.

P. & W. No. 1 AUTOMATIC.

$$\frac{\text{TANGENT OF ANGLE.}}{\text{FEED PULLEY CONSTANT.}}$$

Deg.	Tangent	RATIOS. 24:1 Feed Pulley Const. 12.7	11.16:1 Feed Pulley Const. 5.91	5.81:1 Feed Pulley Const 3.07	4:1 Feed Pulley Const. 2.18	3.1:1 Feed Pulley Const. 1.64	2.7:1 Feed Pulley Const. 1.43
1	.01746	.00137	.00295	.00568	.0080	.01064	.01220
1½	.02619	.00206	.00443	.00853	.01201	.01596	.01831
2	.03492	.00274	.00591	.01137	.01601	.02129	.02441
2½	.04366	.00343	.00738	.01422	.02002	.02662	.03053
3	.05241	.00412	.00886	.01707	.02404	.03195	.03665
4	.06993	.00550	.01183	.02277	.03207	.04264	.04897
5	.08749	.00688	.01480	.02849	.04013	.05334	.06118
6	.1051	.00827	.01778	.03423	.04821	.06408	.07350
7	.12278	.00966	.02077	.040	.05401	.07608	.08586
8	.14054	.01106	.02378	.04577	.06447	.08569	.09828
9	.15838	.01247	.02679	.05158	.07265	.09655	.11075
10	.17633	.01388	.02983	.05687	.0800	.10648	.1220
11	.19438	.01530	.03289	.06331	.08916	.11852	.13593
12	.21256	.01673	.03596	.06923	.09750	.12961	.14864
13	.23087	.01817	.03906	.07520	.10590	.14077	.16144
14	.24933	.01963	.04218	.08122	.11437	.15203	.17435
15	.26795	.02109	.04533	.08728	.12291	.16338	.18737
16	.28675	.02257	.04851	.09340	.13153	.17487	.20053
17	.30573	.02407	.05173	.09959	.14024	.18642	.2138
18	.32492	.02558	.05494	.10583	.15863	.19812	.22721
19	.34433	.02711	.05995	.11216	.15795	.20996	.24078
20	.36397	.02865	.06158	.11855	.16695	.22193	.25453
21	.38386	.03022	.06495	.12503	.17608	.23406	.26843
22	.40403	.03181	.06836	.13160	.18533	.24635	.28253
23	.42447	.03342	.07182	.13826	.19470	.25882	.29613
24	.44523	.03505	.07533	.14502	.20423	.27148	.31135
25	.46631	.03671	.07890	.15189	.21390	.28433	.32609
26	.48773	.03761	.08252	.15887	.22272	.29739	.34107
27	.50953	.04012	.08621	.1660	.23373	.31069	.35631
28	.53171	.04186	.08996	.17319	.24390	.32421	.37183
29	.55431	.04364	.09379	.18055	.25427	.338	.38763
30	.57735	.04545	.09769	.18805	.26483	.35201	.40374
31	.60086	.04731	.10166	.19572	.27562	.36637	.42018
32	.62487	.04920	.10573	.20354	.28633	.38101	.43697
33	.64941	.05113	.10988	.21153	.29789	.39598	.45413
34	.67451	.05311	.11413	.21971	.30941	.41128	.47168
35	.70021	.05513	.11837	.22808	.32119	.42695	.48965
36	.72654	.05720	.12293	.23665	.33327	.44301	.50807
37	.75355	.05870	.12750	.24545	.34566	.45945	.52695
38	.78129	.06151	.13219	.25449	.35839	.47639	.54635
39	.80978	.06297	.13701	.26377	.37147	.49376	.56628
40	.8391	.06607	.14198	.27332	.38491	.51164	.58678
41	.86929	.06844	.14709	.28315	.39876	.53005	.60789
42	.9004	.07089	.15218	.29329	.41302	.54902	.62965
43	.93252	.07342	.15778	.30375	.42730	.56861	.65211
44	.96569	.07525	.16338	.31455	.44297	.58884	.67531
45	1.0000	.07881	.16920	.32573	.45871	.60975	.69930
46	1.03553	.08153	.17522	.33730	.47477	.63140	.72414
47	1.07237	.08443	.18145	.34930	.49145	.65388	.74991
48	1.11061	.08745	.18792	.36176	.50941	.67720	.77665
49	1.15037	.09058	.19481	.37471	.52769	.70144	.80445
50	1.19175	.09383	.20165	.38819	.54667	.72667	.83332
52	1.27994	.10078	.21657	.41691	.58713	.78045	.89506
55	1.42815	.11245	.24165	.44833	.65511	.87082	.99871
57	1.53986	.12124	.27747	.50158	.70635	.93878	1.07682
60	1.73205	.13638	.29306	.56418	.79451	1.05612	1.21122

$$\text{Correct Feed per one Revolution of Head Spindle} = \frac{\text{Tan. of Angle}}{\text{Feed Pulley Const.}} \times \frac{\text{Feed Pulley}}{\text{Counter Drum.}}$$

TABLE 4. FOR FINDING THE CORRECT FEED PER REVOLUTION OF SPINDLE OR THE DIAMETER OF FEED PULLEY, FOR ANY GIVEN CAM ANGLE

Feed Changes

The figures in the different ratio columns in Table 4 actually show the rates of feed per revolution of spindle which would be obtained if the feed pulley and spindle-driving drum on the countershaft were of the same diameter, and by following across the table on any horizontal line the possible variations obtainable by the six different ratios of gears for use in the feed mechanism will be clearly seen. The actual feed changes produced by different angles of cams and various sizes of feed pulleys and counter drum with a given ratio of gearing are shown by Table 5, which is worked out for the No. 1 automatic and for a 24 to 1 ratio of feed gearing. It will be apparent from this table that very fine changes of feed are obtained with any given feed pulley and counter drum by slight modification in cam angles; the entire range, of course, being greatly increased when we introduce the gears of other ratios into the feed drive.

It should be borne in mind that after the machine has been cammed in accordance with the method described, the rate of feed per turn of spindle derived from the cam may be increased or decreased by changing the gears in the feed motion without affecting the rate of turret-slide travel during the indexing movement. This is due to the fact that the indexing is accomplished with the feed-motion pulley clutched direct to the cam shaft for driving the cam drum, that is, the "fast motion" is then in operation and this drives at a constant speed unless the feed pulley on the countershaft is changed, or the speed of the counter itself altered by shifting the position of the belt on the three-step driving cone. While the indexing cams are laid out for performing their work with the turret slide traveling at about 20 feet per minute, some departure may be allowed either way from this normal rate, such, for instance, as might be due to a slight change in diameter of feed pulleys.

The Two-speed Spindle Drive

It is quite common practice now, with the Pratt & Whitney automatic, to equip it with a two-step pulley for operating the head spindle in place of the single-diameter drum formerly universally used for this type of machine. This gives the spindle two rates of speed (ordinarily 2 to 1) and the higher speed is generally employed for the backing belt. Thus, a suitable countershaft speed may be selected for the rough turning cut and for

threading, using the forward belt (except in very unusual cases where a left-hand thread is to be cut) and the fast backward speed is then utilized for finish turning and cutting off, a left-hand finishing box tool being used and the cut-off being carried on the rear end of the cross slide. If a forming tool is required, this is carried at the front of the cross slide and operated while the roughing box tool is cutting, with the spindle operating at its slow speed. The spindle then reverses upon the completion of the rough-turning and the forming operation, and runs backward at double the forward speed while the finishing tool is in operation. If the piece is to be threaded, the slower forward speed is utilized while cutting; and after the die has run on, the spindle again reverses to high speed while the die is run off and the cut-off tool severs the work from the bar. This two-speed arrangement is a very advantageous one as it makes it possible to drive the spindle at speeds best adapted for the cuts taken by the different classes of tools used on the work, and thus greatly increases the output.

In plotting out cam angles for use in connection with the two-spindle drive it is advisable to reduce all feeds per revolution to what they actually would be in case only one of the two speeds was used, and thus simplify the problem.

For example, if we have a constant feed of 0.005 inch per revolution at 100 revolutions per minute, and another constant feed of 0.005 inch at 200 revolutions per minute it is advisable to consider both at the same number of revolutions per minute. To reduce the former to the latter $= 0.005 \text{ inch} \times \frac{100}{200}$ or 0.0025-inch feed at 200 revolutions per minute, while the latter would, of course, remain 0.005. The tangents of the angles for the cams to be used would, of course, be 2 to 1, while the actual feeds per revolution at the speeds used are equal.

Fig. 17 shows a cam lay-out for a machine using the two-speed spindle drive, the turret cam drum surface development being shown in two sections for convenience. The forming and cutting-off cams are sketched in at the side of the drum lay-out with the circles drawn to clearly indicate where the forming and cut-off operations commence and end. The cams shown are suitable for general screw work, the first cam *A* being a plain 50-degree stop cam which holds the turret in its forward position, while the stock feeds out. Cam *B* for the roughing box tool, and the forming cam on the cross-slide disk, are in operation while the spindle runs at its slow speed, and cam *C* for the finishing cut feeds the finishing box tool over the work with the spindle operating at its fast speed. The slow spindle speed is used while the die is run on by cam *D*, and the fast speed is again employed during the cutting-off operation. It will be noticed that extra space is left between the end of the die cam *D* and the last draw-back cam. This extra clearance is provided in order that the die may have ample time to run up on the screw and reverse before the draw-back cam comes into action against the turret-slide roll. Where an opening die is used, mounted in a sliding holder, the die cam may be made shorter as indicated by the dotted lines.

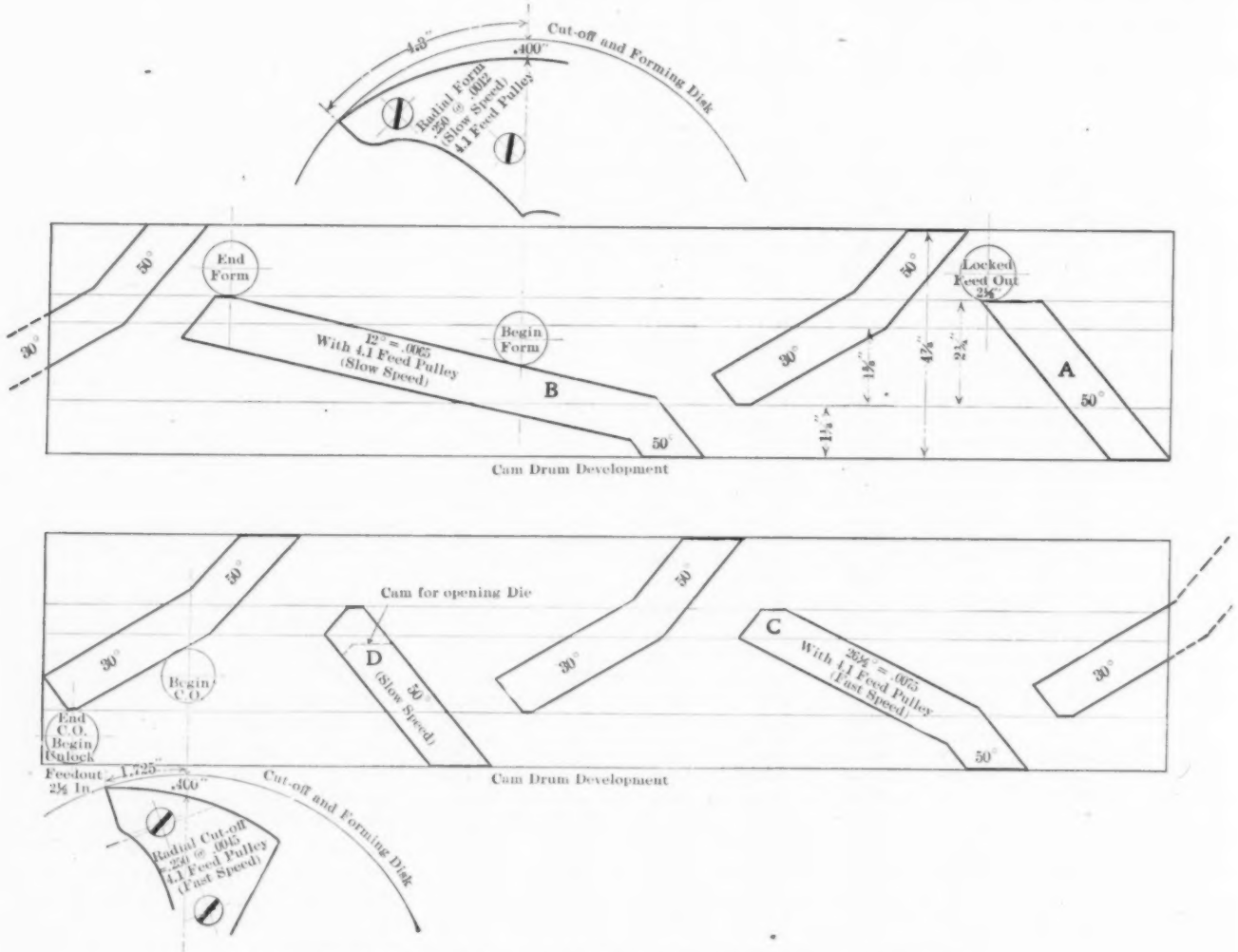


FIG. 17. SET OF CAMS FOR REGULAR SCREW WORK WITH TWO-SPEED SPINDLE DRIVE

of the work of finishing the under side of the head.

Putting on the Cams

A few words regarding the forming and placing of the cams in position on the drums and cut-off disk may not be out of place here. After the angles, lengths, etc., have been found the cams may be cut from the flat stock to the right length and proper angles at the ends by means of a saw in the milling machine, swiveling the vise to give the required angles for the ends, and then the holes for the tap bolts are drilled, after which the cams are bent to conform to the curvature of the drum. Tough steel that will admit of being hardened should be used, and after the pieces are hardened they are located one by one on the drum, and the latter drilled and the holes tapped for the tap bolts which secure the cams in place. The turret-slide cams are located in the right positions relative to the chucking drum cams by squaring across from the chuck-closing cam on that drum, this giving the right location for the first cam on the turret-slide drum. It must be kept in mind that the chuck-closing cam must close the chuck completely before the cutting part of the first cam on the turret drum comes into contact with the cam roll.

The forming and cutting-off cams are located on their disk so that the ends of these cams are just passing the ends of the cross-slide levers when the points on the turret cams marked in the lay-out "end of forming" and "end of cut-off" are just in contact with the turret-slide roll. The idea will be clear from the drawing in Fig. 17.

Some further points on camming, touching on some special problems that arise quite frequently in connection with screw-machine work will be taken up later.

STEEL CUTTING FEED PER REVOLUTION OF SPINDLE.

P. & W. No. 1 REG. AND No. 1 SPEC. AUTOMATIC SCREW MACHINES

Angle of Cam. Deg.	For 11" Counter Drum Spindle Speeds 653–496–396				For 12" Counter Drum Spindle Speeds 713–541–432				For 14" Counter Drum Spindle Speeds 832–631–504				For 16" Counter Drum Spindle Speeds 950–722–576			
	Diam. of Feed Pulley.				Diam. of Feed Pulley.				Diam. of Feed Pulley.				Diam. of Feed Pulley.			
	3"	4"	5"	6"	3"	4"	5"	6"	3"	4"	5"	6"	3"	4"	5"	6"
3	.00110	.00147	.00184	.00221	.00101	.00135	.00169	.00202	.00087	.00116	.00145	.00173	.00076	.00101	.00126	.00152
4	.00147	.00196	.00245	.00295	.00135	.00180	.00225	.00270	.00116	.00154	.00193	.00231	.00101	.00135	.00169	.00202
5	.00184	.00246	.00307	.00369	.00169	.00225	.00282	.00337	.00145	.00193	.00241	.00289	.00127	.00169	.00211	.00253
6	.00221	.00295	.00369	.00443	.00203	.00271	.00338	.00406	.00174	.00232	.00290	.00348	.00152	.00203	.00254	.00304
7	.00259	.00345	.00431	.00517	.00237	.00316	.00395	.00474	.00203	.00271	.00339	.00406	.00178	.00237	.00296	.00355
8	.00296	.00395	.00493	.00592	.00271	.00362	.00452	.00543	.00233	.00310	.00388	.00465	.00204	.00271	.00339	.00407
9	.00334	.00445	.00556	.00667	.00306	.00408	.00509	.00611	.00262	.00350	.00437	.00524	.00229	.00306	.00382	.00459
10	.00371	.00495	.00619	.00743	.00340	.00454	.00567	.00681	.00292	.00389	.00486	.00584	.00255	.00340	.00426	.00511
11	.00409	.00546	.00682	.00819	.00375	.00500	.00625	.00751	.00322	.00429	.00536	.00643	.00281	.00375	.00469	.00563
12	.00448	.00597	.00746	.00895	.00410	.00547	.00684	.00821	.00352	.00469	.00586	.00704	.00308	.00410	.00513	.00615
13	.00486	.00648	.00810	.00973	.00446	.00594	.00743	.00890	.00382	.00510	.00637	.00764	.00334	.00445	.00557	.00668
14	.00525	.00700	.00875	.01051	.00481	.00642	.00802	.00963	.00412	.00550	.00687	.00825	.00361	.00482	.00602	.00722
15	.00564	.00752	.00940	.01129	.00517	.00690	.00862	.01035	.00443	.00591	.00739	.00887	.00388	.00517	.00646	.00776
16	.00604	.00805	.01006	.01208	.00554	.00738	.00923	.01108	.00475	.00633	.00791	.00949	.00415	.00554	.00692	.00830
18	.00684	.00912	.01140	.01369	.00627	.00836	.01045	.01255	.00538	.00717	.00896	.01075	.00470	.00627	.00784	.00941
20	.00767	.01022	.01278	.01534	.00703	.00937	.01171	.01406	.00602	.00803	.01004	.01205	.00527	.00703	.00878	.01054
22	.00851	.01135	.01418	.01702	.00780	.01040	.01300	.01560	.00669	.00892	.01114	.01337	.00585	.00780	.00975	.01170
24	.00938	.01250	.01563	.01876	.00860	.01146	.01433	.01720	.00737	.00983	.01228	.01474	.00645	.00860	.01074	.01289
25	.00982	.01310	.01637	.01964	.00900	.01200	.01500	.01801	.00772	.01029	.01286	.01543	.00675	.00900	.01125	.01351
26	.01027	.01370	.01712	.02055	.00942	.01256	.01569	.01883	.00807	.01076	.01345	.01615	.00706	.00942	.01177	.01412
28	.01120	.01493	.01866	.02240	.01027	.01369	.01711	.02053	.00880	.01173	.01466	.01760	.00770	.01027	.01283	.01540
30	.01216	.01622	.02027	.02432	.01115	.01486	.01858	.02230	.00955	.01274	.01592	.01911	.00836	.01151	.01393	.01672
32	.01316	.01755	.02193	.02632	.01207	.01609	.02011	.02413	.01034	.01379	.01723	.02068	.00905	.01206	.01508	.01810
34	.01421	.01894	.02368	.02842	.01302	.01736	.02170	.02605	.01116	.01488	.01860	.02233	.00977	.01302	.01628	.01954
35	.01475	.01966	.02458	.02949	.01352	.01803	.02253	.02704	.01159	.01545	.01931	.02318	.01014	.01352	.01690	.02028

TABLE 5. AUTOMATIC SCREW MACHINE FEEDS, PRATT & WHITNEY NO. 1 MACHINE (24 TO 1 FEED MOTION)

Marking Patented Articles

By Irving D. Kimball

Many patentees do not realize the importance of marking their inventions as patented and affixing the date of their patent, in accordance with section 4900 of the Revised Statutes, which reads:

"Sec. 4900. It shall be the duty of all patentees, and their assigns and legal representatives, and of all persons making or vending any patented article for or under them, to give sufficient notice to the public that the same is patented; either by fixing thereon the word 'patented,' together with the day and year the patent was granted; or when, from the character of the article, this cannot be done, by fixing to it, or to the package wherein one or more of them is inclosed, a label containing the like notice; and in any suit for infringement, by the party failing so to mark, no damages shall be recovered by the plaintiff, except on proof that the defendant was duly notified of the infringement, and continued, after such notice, to make, use, or vend the article so patented."

To illustrate in a simple manner, let us suppose A has a valuable patent, but neglects to mark the article covered thereby. B may suppose in absence of such notice that it is not patented and may make and use or sell a large number of them. This may result in a serious loss to A's business; but as he has not notified the public that his article is patented, he is not protected by law and can collect no damages. If, however, upon finding that B is making his invention, A notifies him to stop such infringement, B can be held accountable for any which he manufactures after the receipt of such notice.

A patent is a public grant which is rightly subject to such restrictions as are necessary to protect the welfare of the public in general. If a man has a piece of land that he doesn't want people to walk upon, he surrounds it by a fence or puts up a sign, saying "No trespassing." If there is no fence or sign, one supposes that there is no objection to a person walking across it. If a man has a patented invention which other people must leave alone he should put a sign on it, in order that the public may know of his right.

The courts, in ruling upon questions arising under this statute, have as a rule held the contestants strictly to the wording of the statute.

In one case the patentee of wooden dishes stamped them "Oval Wooden Dish," and the crates in which they were shipped with the word "Patented," and the date of the patent. The court held that the stamping of the word "Patented" on a crate containing patented articles could not be construed to be either a marking of the word *upon* the articles or *affixing* it to them as required by the statute. The

statute clearly states that the notice can only be affixed to the package when the nature of the patented article does not admit of its being marked. The assertion that to mark the notice on the dishes would so add to their cost that they could not be sold at a profit does not permit a deviation from the letter of the law. It is not the intent of the law to protect the patentee in disobeying the law. Smith vs. Walton, 51 Fed. Rep. 17.

From this it is clear that the inventor or manufacturer must carefully determine what method of marking will give him the protection of the law. On a machine it is a simple matter to have the notice cast on or fastened to the machine in the shape of a name plate. But on such an article as a hair-pin, for instance, it would be necessary to place the notice upon the box or wrapper containing them.

It is necessary that each article should be stamped with the day and year, but this is sufficient even if the word "patented" is abbreviated. Hawley vs. Bagley, Fed. Cas. 6248.

Marking an article "patented," not with the day and year of the patent which covers it, but with the date of a previous patent to the same inventor upon which the later patent is an improvement, is not a compliance with the statute and gives the patentee no right to recover damages. Traver v. Brown, 62 Fed. Rep. 933.

In Wilson v. Singer Mfg. Co., Fed. Cas. 17,836, it was held that there was no liability attached to affixing the word "patented" and the date after the patent had expired.

In Goodyear v. Allyn, 3 Fish, P. C. 374, it was held that where a patent is divided among several owners, failure of one to mark does not affect the rights of the others.

Manufacturers and inventors should see to it that as soon as a patent issues, its date, with the word "Patented" or "Pat.," is put upon the article; or, if this is impossible owing to its nature, that a label is affixed either to the article or the package containing it, giving the information. Having paid out good money for a patent, is is a simple matter lawfully to notify the public of such right, thereby avoiding misunderstandings and expensive lawsuits.

The sale of electrical goods in Rio Janeiro is extremely active, and all American manufacturers now represented in Brazil are are doing a fine trade.

Monnot Copper-clad Steel

Many attempts have been made to make rods or sheets with an iron or steel core and a copper covering to protect it from oxidization by water, gases and acids. It has been very difficult to secure a coating which was at all homogeneous, and the union of the two metals has never been entirely satisfactory. The most successful attempt was probably that of Edward Martin, of Paris, who used a rolling process to produce a copper wire with a steel core or a steel wire with a copper covering, whichever you prefer to call it. The product was fairly satisfactory, but the cost was prohibitive from a commercial standpoint. There has also been some fairly good work of this kind done in Germany, but the cost has been very much more than for pure copper.

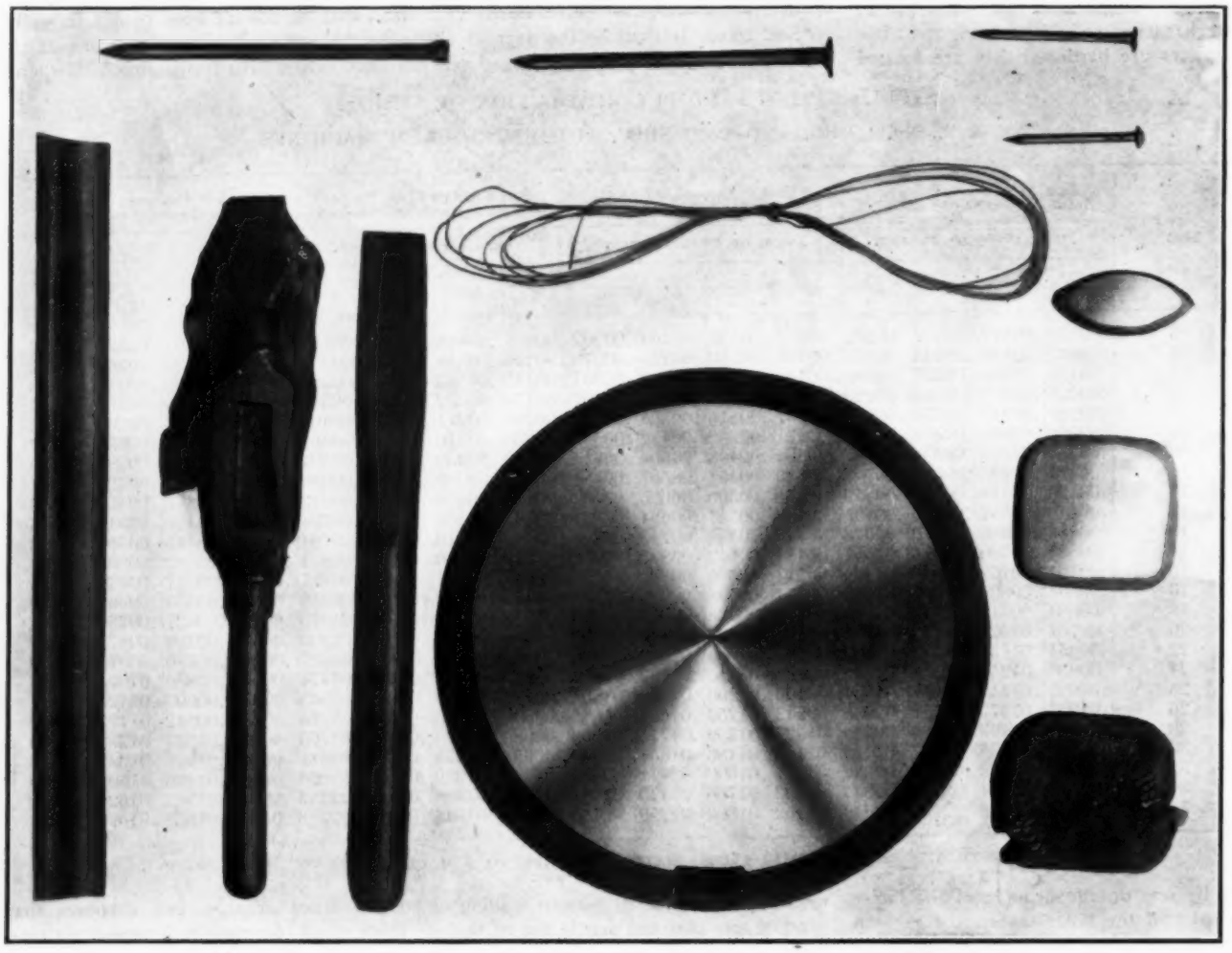


FIG. 1. A COPPER-CLAD STEEL BILLET AND PIECES MADE FROM IT

The process which has made this a commercial product is due to J. Ferreol Monnot, a French metallurgist, for whom the product is named.

Roughly speaking, the process consists in taking a bar of steel, usually round and about four inches in diameter, and dipping it into a crucible or pot of molten

copper. Then a sleeve of such diameter that the annular space between the bar and the sleeve determines the thickness of the copper coating it receives is lowered over the bar. Any thickness of copper desired can be obtained in this way, and the copper-clad bar is then rolled or worked down to any size or shape called for. With all this working, the copper and steel are both reduced in the same proportion, so that if the original bar has 20 per cent. copper the reduced bar or wire, if it be drawn down to that, will have approximately the same proportion of steel and copper. This always preserves the copper coating as a protector against corrosion.

This coating is thoroughly united to the steel itself and cannot be separated by twisting or by the use of a cold chisel except to cut off the piece running immediately in front of the cutting edge, the same as can be done with the steel itself. So that even should the copper coating be injured at any point, the corrosion could not work its way along under the skin as would be the case were the copper not firmly united to the steel. It localizes any corrosion to the immediate point of injury.

The homogeneity of the copper coating has been shown by tests of the metal in acids as compared with plain steel. Acid baths that entirely dissolved bare steel in a few days did not affect the copper-clad material, as proved by the test of strength of the wire both before and after. Tests of the acid showed no trace of iron, showing that the covering was so solid that it could not get through to attack the steel.

The illustrations in Fig. 1 show a section from the original bar and show the copper covering very clearly. At the bottom, two saw cuts were made and in the endeavor to break off the copper covering, both copper and steel bent; but there was no sign of any separation between the metals. Near this is shown a smaller section which has withstood a cold-chisel attack without failing in any particular. Just above this are two other sections which show how the thickness of the copper reduces as it is rolled or drawn down; above the large sections by way of contrast, is some small wire drawn from the same bar. Although the copper is very thin on this wire, it is a protective covering just the same. At the left is a copper-covered coldchisel of carbon steel, the object being to protect the steel against decarbonizing and the detrimental action of sulphur or harmful gases. This seems the least practical of any of the uses shown, and it does not seem as though the benefits would warrant the cost.

Next comes a drop forging from copper-clad stock, on which the copper covering is apparently intact at all points.

Next is a blade from a Westinghouse turbine, drawn from the copper-clad steel.

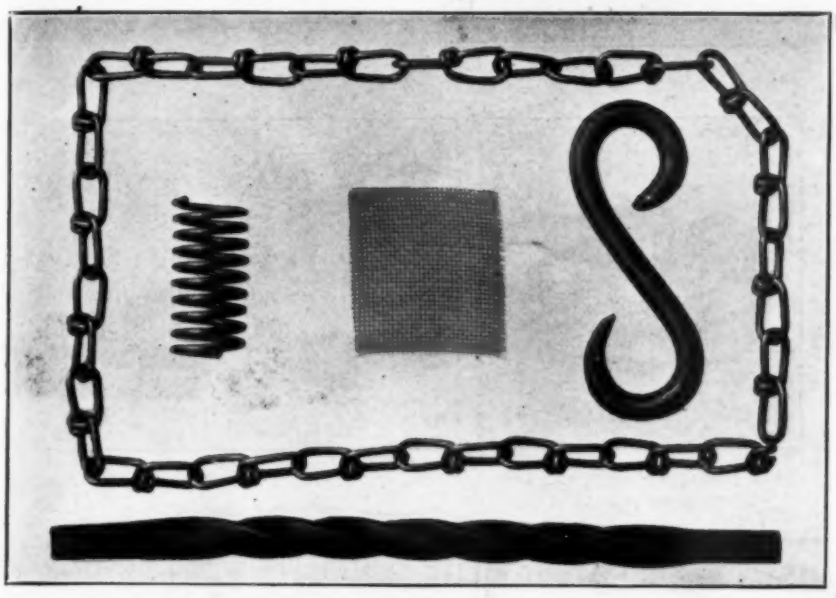


FIG. 2. MORE EXAMPLES OF COPPER-CLAD STEEL

It is interesting to note that, after satisfactory tests, the Westinghouse Machine Company has adopted this metal for all its turbines.

The blade shown has a complete copper covering to protect the steel from the action of the steam. The copper is very hard from drawing to this shape, and makes a good durable coating.

Another use is shown in the various-sized nails, which are steel with a fairly heavy coating of copper. These are particularly useful in boat work and for roofs and similar places. Besides being cheaper than copper they have the advantage that they can be driven the same as a steel nail, while the copper nail must have a hole bored for it and is very apt to come loose in the hole.

One of the principal uses for such a product is probably in the shape of wire for electrical purposes, although it is equally good for guy wires or in any other place where bare steel is attacked by its enemies in the shape of gases, acids or the elements.

The combined wire has a conductivity just in proportion to the amount of copper and steel it contains, but there are many places where copper wires are used much larger than needed to conduct the required current, in order to secure sufficient strength and to protect against mechanical injury. This is particularly true in telephone work, and the copper-coated wire should present quite an opportunity for saving money in such cases.

It is also useful for roof covering, exhaust heads, pump rods, ship bottoms and engravers' plates, saving in the cost of copper in each case.

The tensile strength will of course be just in proportion to the amount and quality of the steel used and need not be considered here. It is evident that the strength of copper-clad sheets is greatly in excess of that of pure copper, thus in many cases allowing an additional saving by using a thinner gage.

Still other uses are shown in Fig. 2, the spring being for use in places where the action of steam, water or acids might weaken or destroy a spring without this covering. For window screens it has the advantage of resisting rust the same as pure copper or brass wire and is not only cheaper but also stronger to resist the assaults of mosquitos from Staten island or other infected districts.

This copper-clad steel is being put on the market by the Duplex Metals Company, 208 Fifth avenue, New York.

A mooring buoy, which is said to be the largest ever laid down, has just been put in position in the Mersey for the use of the Cunard liners "Lusitania" and "Mauretania." The buoy weighs some 17 tons. The mooring cables are of square section with stud links, and these, together with the anchors and shackles, aggregate 230 tons 13 cwt. The two shackles at the top of the buoy weigh 11½ cwt. The enormous size of the ships and the strong tidal currents—up to six or even seven knots—that run in the river make the use of such massive ground tackle necessary to insure safety, for the vessels will spend practically the whole of their stay in the port at the buoy.—*Mechanical Engineer.*

Steel for Manchuria

The steamship "Kabinga," of the line which is to operate between New York, Dalny, and Port Arthur, sailed from New York recently with a 12,000-ton cargo of steel equipment for the Manchurian Railroad, furnished chiefly by the United States Steel Corporation. Within the next twelve months 163,000 tons of rails, 8000 tons of bridges, 250 locomotives, and 3000 cars will be shipped to Dalny, the principal seaport terminus of the South Manchurian system.

Making the One-lock Adjustable Reamer

Some of the tools used in making the one-lock adjustable reamer of the W. J. Smith Company, New Haven, Conn., are interesting examples of modern manufacturing and ought to contain suggestions that will be of service in other kinds of work. This reamer was shown in detail on page 35 of the current volume and as the largest portion is the body or shell we begin by showing how it is made.

The chuck shown in the center of Fig. 1 holds the body, which is cut from bar stock, while it is being bored by the tool shown at the left. This first operation is to run in a drill the size of the pilot on the boring tool and then the rest is bored very rapidly at one cut. The illustration does not show clearly the angle of the cutting blades but an idea of this can be had from the lower blade and the angle of the screw which holds it in place. These blades are of high-speed steel and the top rake enables a very clean chip to be rolled out as shown by the long shaving in the illustration. This is turret lathe work and a very good example of removing stock quickly and easily.

These shells are then turned on an arbor which is clamped by the double-ended dog shown in Fig. 2 and driven by the two-eared face plate or driver. The double drive is gaining friends in many places and this is a very neat application of it

The cam bolt is turned and threaded in the usual way, then goes to the milling machine in Fig. 4 where the cam surfaces, one for each blade of the reamer, are milled with a formed cutter. A finished bolt is shown, with its cutter, on the milling machine table.

The reamer blades make quite an interesting proposition in several ways. They must fit the slots without lost motion, and the small dovetailed projection must fit in and be operated by the cam bolt with its undercut groove in the center. In addition to being merely of the correct outline the prong or projection of this dovetail must be curved to the right radius to fit the cam bolt and this is done by the internal milling cutter shown in Fig. 5. The blade is held at the proper angle by the small fixture shown and they can be done very rapidly.

The slots through the reamer arbors are cut on the rather unusual oscillating milling machine built by the Hendey Machine Company and shown in Fig. 6. The cutter oscillates and works its way through an arbor more quickly than might be imagined. The same machine cuts out the hexagon sockets in the wrenches for locking the cam bolts in place.

As a guide in adjusting the blades of these reamers the ends of the shells are graduated so that very fine adjustments may be made and the machine for doing this is shown in Fig. 7. The shell is mounted on a taper drawing pin and bushing which lock it to the index plate of the machine. The index has a ratchet which moves the shell just the desired space each time. The marking cutter is shown at the top and is carried on a cross slide. A movement of this gives the graduating mark and a variable stop motion determines whether the line is to be long or short. This is a well designed little tool and does excellent work.

The proper clearance is given the blades by a neat device shown in Fig. 3. While this appears to be a regular reamer, the slots are not radial as in the usual shell

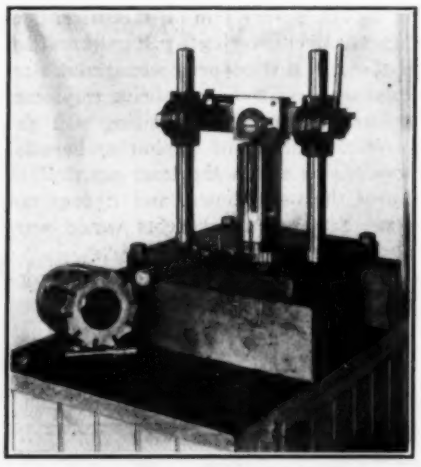


FIG. 7. GRADUATING MACHINE

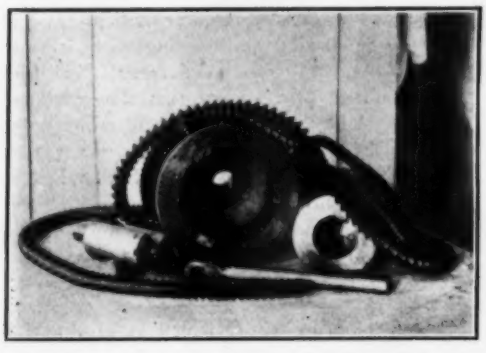


FIG. 1. CHUCK, BORING TOOL, CHIPS AND SHELL

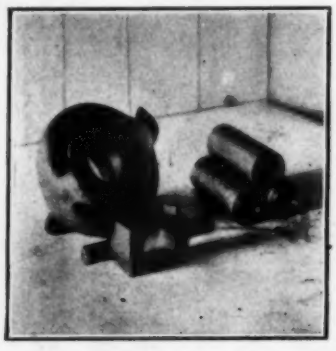


FIG. 2. DOUBLE-DRIVE DOG AND FACE PLATE

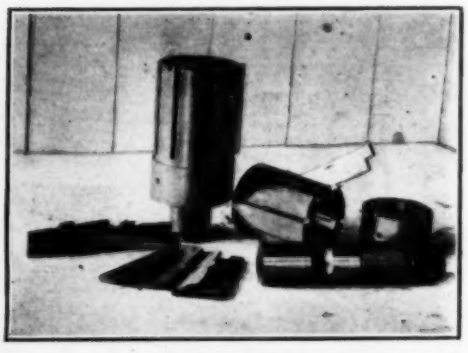


FIG. 3. FIXTURE FOR GRINDING THE CLEARANCE OF BLADES

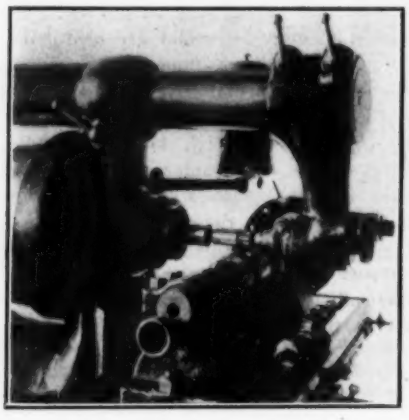


FIG. 4. MILLING ADJUSTING CAM BOLT

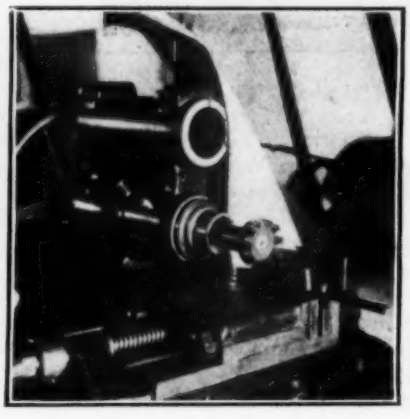


FIG. 5. MILLING CURVE ON LUG OF BLADE

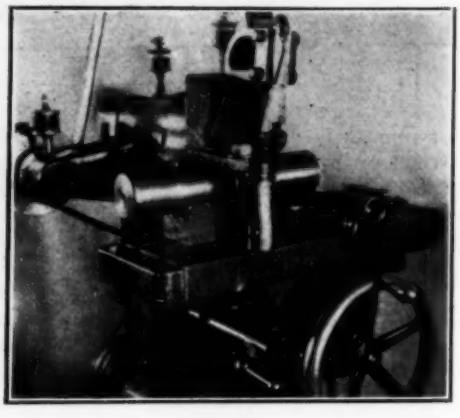


FIG. 6. OSCILLATING MILLING MACHINE AT WORK

but are set forward just enough to grind off the required amount behind what becomes the cutting edge when the blades are transferred to the regular reamer shell. The central bolt of the jig is not cammed but holds the blades in the same way.

A German Factory on American Soil

By C. Dickens Sternfels

We are apt to think only of our American industrial expansion and growth, and of the reaching out of our large corporations into other countries and of the establishing of Americanized factories on foreign soil. Does it ever occur to us, however, that the reverse may be true; that foreign corporations sometimes establish factories in this country?

A manufacturing plant has recently been put in operation at a new town, called Koppel, in the Beaver River valley of Pennsylvania, which can be called a German factory on American soil. It is one of the plants of the Arthur Koppel Company. This company has five factories in continental Europe and this one near Pittsburg. While it is an outgrowth of the European business, still American ideas and men have entered to a very great extent into its design, construction and organization. In the personnel, the president of the company, the chief engineer and some of his assistants are from abroad, while all others are drawn from this country. It is essential that the chief executive officer should come from one of the existing plants and so be in a position to carry out a policy along established lines. For a similar reason it is not surprising that the chief engineer should be a man fully conversant with existing designs and standards in order to keep uniformity in the product; but, as we have stated, except for these two essential elements of the organization the men have been recruited from this country.

One of the first moves toward the beginning of the plans for this plant was the selection of a superintendent to take up the work of its design and ultimately of its operation. The man, who is an American, was sent to Europe, where he spent five months in visiting the parent plant and studying its designs and methods of manufacture. After his return to this country a general plan of the plant was developed and a search made for a suitable site. In general the vicinity of Pittsburg was determined upon as the most desirable section. About 200 plots of land were looked over extending from Wheeling, West Virginia, on the south, to Youngstown, Ohio, on the north, and along both banks of the Monongahela, Allegheny and Ohio rivers near the city of Pittsburg itself. For about 30 of these plots a detailed report was prepared, giving data arranged under 39 different heads. This report stated in detail the location of the proposed site from the important industrial centers of Pittsburg, Chicago, Cleveland, Cincinnati, Buffalo and New York. It gave the population of the town or city near which it was located and a description of all public institutions, such as libraries, colleges, hospitals, churches, etc. The points of railroad facilities, switching conditions and service, location of the local freight stations, freight and express rates to the cities mentioned above, as well as to Philadelphia and St. Louis, were carefully

FIG. 1. THE ERECTING SHOP, SHOWING THE EXCELLENT NATURAL LIGHT

itemized. Telephone and telegraph costs and tolls were noted.

Considerable space was given to the question of labor, including an estimate of the available supply of machinists, skilled and unskilled labor, the average rate of wages for the various classes and union organizations. The cost of fuel, coal, natural gas and artificial gas was accurately obtained and tabulated; the cost and proximity of electric power was ascertained. The natural points at which raw materials, such as sheets, plates, castings, bolts, etc., would be purchased were noted, with their accompanying freight rates. And, lastly, the conditions of purchase of the plot were outlined.

These data seem to be in much detail, but they are surely the vital facts which should be known in selecting a factory site. The result of this analysis was the selection and purchase of a plot of ground comprising about 700 acres in the Beaver River valley, some 30 miles from the city of Pittsburg. No town of any size was near the site, but one is already springing up around the factory. The plant was laid out to have a maximum capacity of 25,000 tons of finished product per year. At first, however, only one-fourth of this has been built, or enough to give a tonnage of 6000 tons of finished product per year.

The manufacturing buildings are in a solid block, arranged for ease in handling the material through the various operations. The prominent feature of the construction is the provisions for natural light.

The largest part of the area of the side walls is glass. The extent to which this window area contributes to the natural interior light is shown by Fig. 1, which is from a photograph of the erecting shop. The feature of excellent natural light for machine shops, and in fact for all building devoted to manufacture, is one which cannot be too highly commended. It contributes directly to the health and comfort of the employees and is one point tending toward better industrial conditions. Ground was broken for the plant on July 9, 1906, and manufacturing was commenced May 1, 1907. This record, together with the extreme care used in the selection of the site, would bear out the statement that there has been a combination of German thoroughness and American energy in its development.

Glass Powder for Needle Valves

A needle valve which is pitted or ridged may be reduced to an even surface by grinding with glass powder. Afterward, however, it is quite important that the seat and duct below it be thoroughly cleaned as otherwise the behavior of the motor may be such as not to cause the carbureter to be suspected as being the seat of the trouble.

A Novel Gear Shaper

By Frank C. Hudson

Having a lot of internal gears to cut, and being unable to use a milling cutter, owing to there being a bottom to the gear, it was necessary to send them out to shops where some sort of a gear shaper was in use. But the charges ranged from a dollar to a dollar and a half a gear for the cutting, so it was decided to make a machine which would do the work at a lower cost.

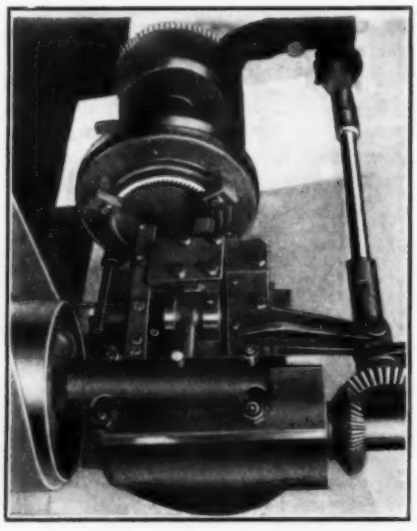


FIG. 1. TOP VIEW OF GEAR SHAPER OR PLANER

The first view, Fig. 1, shows a top view of the machine, taken by using a "C" clamp to fasten the camera to an overhead beam. It shows one of the gears in place with the cutter ready to go to work and gives a general view of the machine. A side and end view is shown in outline in Fig. 2.

How It Works

A belt on pulley *P* drives the machine. Through a pair of gears, which reduces the motion one-half, it gives motion, through the connecting-rod shown, to the slide carrying the tool *T*.

At the other end of the machine is the indexing ratchet wheel *I*, the brake wheel *B*, which carries the feed cam *C* and the chuck *D* for holding the work. The way in which this is held is shown clearly in Fig. 1, and it will also be seen that the front portion is changeable for different-sized gears.

The bevel gears at the right of Fig. 1 drive the spacing mechanism shown at the back and in the end view of Fig. 2, revolving the cam *J*, which forces the pawl *K* against the wheel *I* and feeds it one tooth. Brake wheel *B*, with the brake below, which is always bearing against the wheel, prevents any jumping of the index and holds the work in place while the tooth is being cut.

At every revolution of the work the cam *C* strikes the roller on the upper end of arm *A* and pulls the rod at its lower end so as to feed the ratchet *F*. Whether this is fed one, two or three teeth is determined by the small levers *L* striking against the stop *S*. With both levers thrown out, it feeds three notches; with the short one in, it feeds two notches; and in the position shown, one notch. This feeds the tool into the work the desired amount at every revolution of the work.

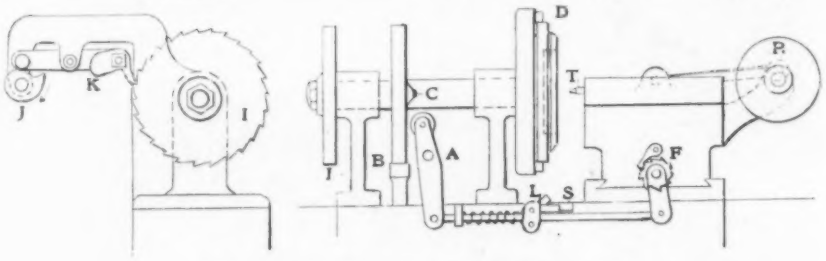


FIG. 2. SIDE AND END VIEW OF GEAR CUTTER

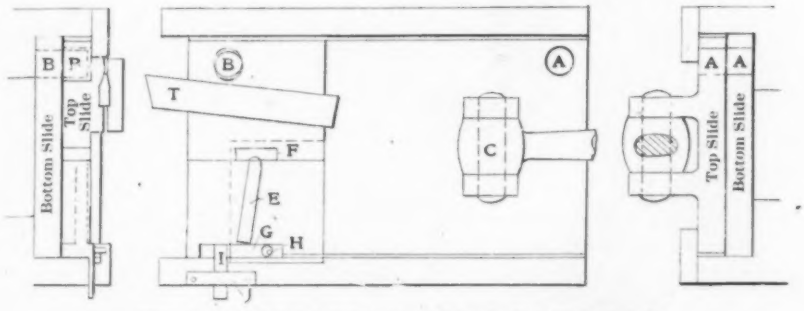


FIG. 3. DETAILS OF SLIDE AND RELIEVING MECHANISMS

Relieving the Cutter on the Return Stroke

The most ingenious part of the whole machine, however, is the device for relieving the tool on the back stroke and for holding it firmly while the cut is being made. Details of this are shown in Figs. 3 and 4.

The end view at the right shows that the slide is made in two parts, an upper and a lower. The lower is the full width of the guide, while the upper is a trifle narrower, as shown. The connecting-rod *C* is coupled to the upper one.

These are fastened together by the pin *A*, which fits tight in the lower slide and allows the upper slide to swing on it. The pin *B* is also fastened in the lower slide, but the upper has an oblong hole to allow a little side movement as shown.

When the slide starts forward, the upper part swings on pin *A* until it strikes pin *B*; when it returns, the pull of the crank swings the upper slide back and pulls the tool out of the cut.

A Neat Toggle Joint

There were times, however, when the tool *T* would get a trifle dull and tend to crowd away from the cut. To obviate this, a small toggle was introduced at the side of the slide opposite the tool, shown in Figs. 3 and 4, the latter being in perspective and perhaps showing it a little better than the other.

A hardened-steel block *F* was let into the slide, and another hardened block *G* used next to the guide with the toggle lever *E*, also hardened in between them. Block *G* carries a small pin projecting through a hole in the upper plate near the

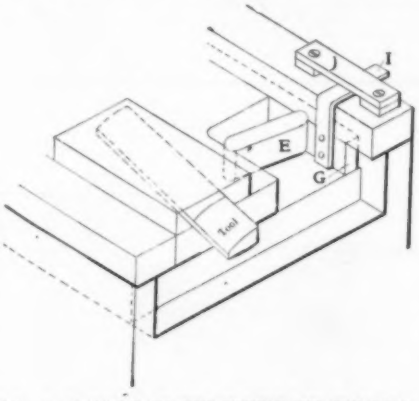


FIG. 4. DETAILS OF THE TOGGLE FOR HOLDING TOOL TO ITS WORK

tool and, acting as a stop in much the same way as the pin *B*, has a slight movement in the oblong hole before stopping the upper slide from side movement.

In starting on the forward stroke, the block *G* has a tendency to stick to the side of the guides or to lag behind the slide. The end of the toggle next to the slide swings ahead and forces the tool into its work in such a way that there is no backing away even if it is dull.

An Extra Friction Slide

As a further precaution, the piece *I* was put on the block *G* and brought up over the edge of the slide and under the friction piece *J*, which can be tightened down to any desired amount so as to insure the block *G* lagging enough always to throw the toggle in and out of position, making a positive cut and a sure release for the tool on the return stroke.

The cross feed is arranged to throw out when the tool has reached its correct depth, and the varying feeds allow the first few cuts around the gear to be much heavier than those used when finishing the tooth.

With this machine running at about 60 strokes a minute, a 96-tooth gear, 8 pitch, the tooth about three-quarters of an inch long, is cut in from 40 to 50 minutes by an apprentice boy, making the cost somewhat less than a dollar apiece for cutting the teeth, as formerly paid.

An Unusual Screw-machine Job

A company manufacturing chemical apparatus found great difficulty in getting castings which would hold the gas they used at the 2000 pounds pressure it was necessary to carry, as the gas would go through the pores of the metal and the valves were not successful in any way. So it was decided to make them of a hard-drawn bronze bar on a Bardons & Oliver lathe with tools designed by that firm. The successive operations are shown in Fig. 1, the valve being cut from the drawn bar. The first operation was the worst, facing down the side of the valve, 4 3/16 x 1⅛ inches, as will be seen in Fig. 2, with a hollow milling tool at one cut. This made a very broad cut on this metal and took more power than might be imagined.

The rest is comparatively easy with the proper chucking facilities and tools, although the interior is rather complicated, with undercutting and recessing, as will be seen in the section, Fig. 2.

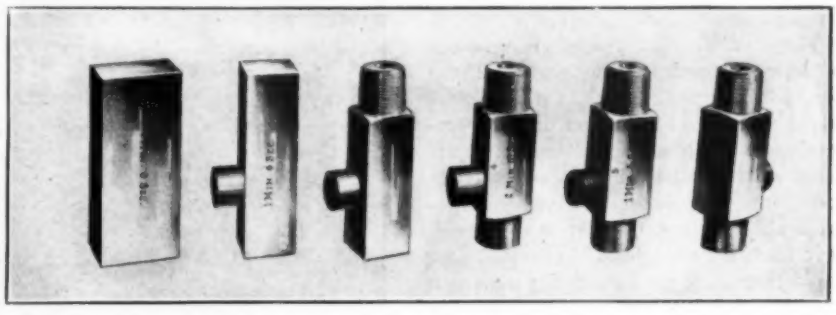


FIG. 1. DIFFERENT STAGES OF THE VALVE BODY WITH TIME

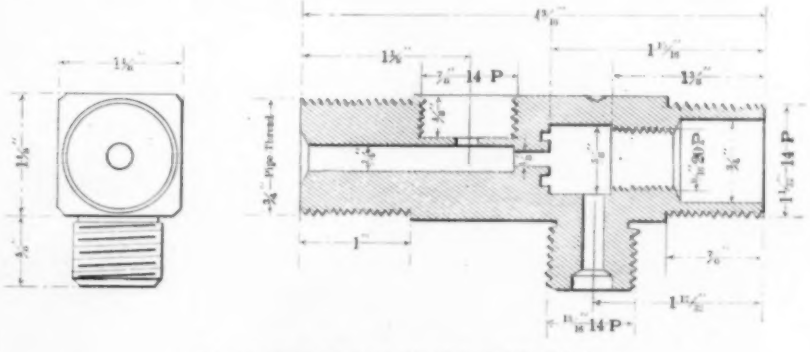


FIG. 2. THE DETAILS OF THE VALVE BODY

The main dimensions are given to show the work to be done and altogether it is a very interesting job, as well as being out of the ordinary.

The Marconi company announces that it will be prepared for wireless-telegraph service between the United Kingdom and Canada in September. The messages will be transmitted between Clifton, Ireland, and Glace Bay, Nova Scotia. The regular rates will be 5 cents per word and the Government and press rates 2½ cents. Great improvements have been made lately to the station at Glace Bay, which has been moved to a more favorable situation and much enlarged. The station at Clifton has also been improved in order to meet the situation. The first stations erected were found to be too small. For some time past the Marconi company has had communications across the Atlantic, and exhaustive tests have been carried on. The company has been transmitting messages from this side to England for some time but it is only recently that the communication from England to Canada was thoroughly successful, and now that the tests have proved satisfactory the company intends entering the commercial field at once.

Consul W. M. Greene, of Hamilton, advises that the new "alien act" came into effect on the island of Bermuda on June 7. By this law foreigners may acquire real property without onerous conditions, and can sell, transfer, or devise such property under about the same conditions as obtain in the United States.

36-inch Vertical Turret Lathe

The acompanying engravings illustrate the 36-inch vertical turret lathe built by the Bullard Machine Tool Company, of Bridgeport, Conn. This machine, as indicated by the title, has a capacity for work 36 inches diameter and it swings 24 inches under the cross rail. Its table has fifteen rates of speed derived through gearing actuated by a constant-speed driving shaft, and these speed changes are obtained by the operation of a pilot wheel whose movements are controlled by an interlocking device by which any possible breakage or delay is obviated. The speed-controlling mechanism includes an indicator giving the speeds of the table in revolutions per minute, and a quick-acting brake enables the operator to stop the table at any desired point.

There are two independent turrets, one of which is carried by the side head, and for each head there are eight rates of feed in any direction. Micrometer dials are provided for the different feeds and these are fitted with adjustable indicators for facilitating the reproduction of various sizes on duplicate pieces. In addition to the regular feeds the main head is provided with rapid traversing mechanism for moving it quickly in any direction and to any required point. There are numerous other important and ingenious features incorporated in the design of this machine, which will be brought out in connection with the various half-tone and line engravings.

The Rails and Saddles

Figs. 1 and 2 show the machine from the front and rear; Fig. 3 represents the machine from the left-hand side and illustrates the method of driving by motor. These three views show clearly the method of mounting the saddles on the rails and the rails on the column. Both

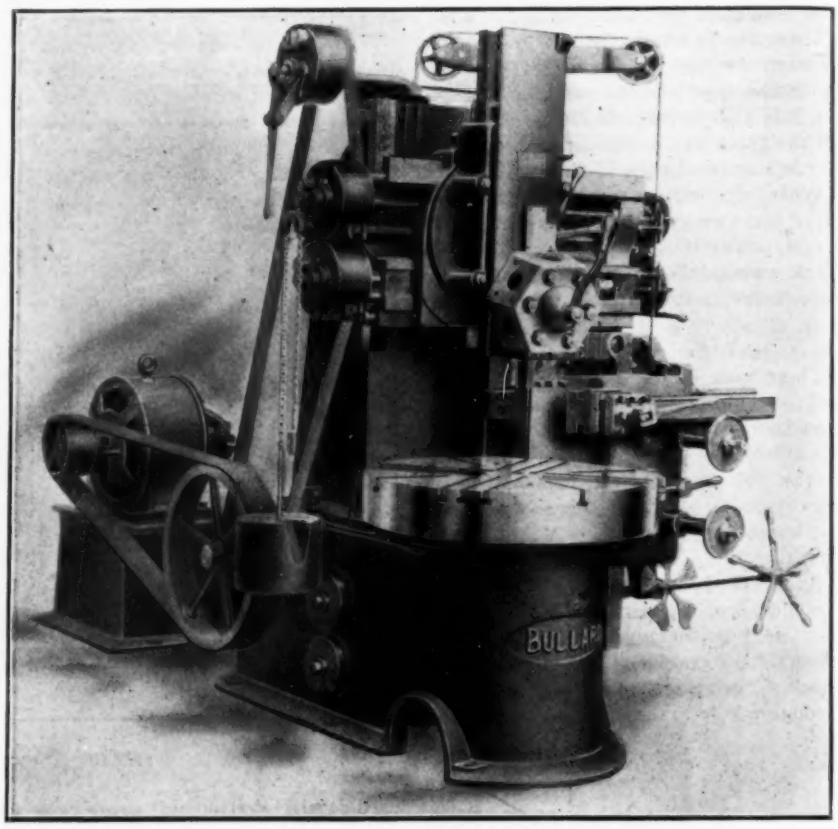
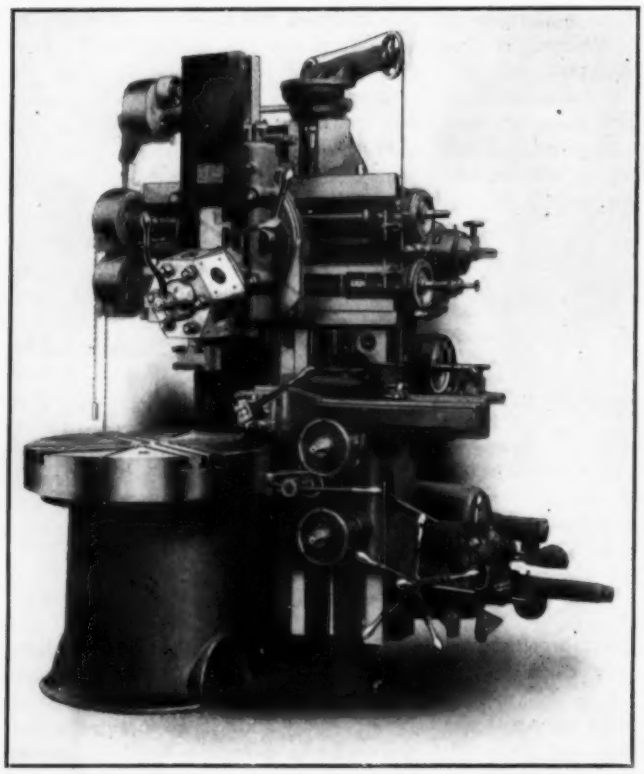


FIG. 3. VERTICAL TURRET LATHE WITH MOTOR DRIVE



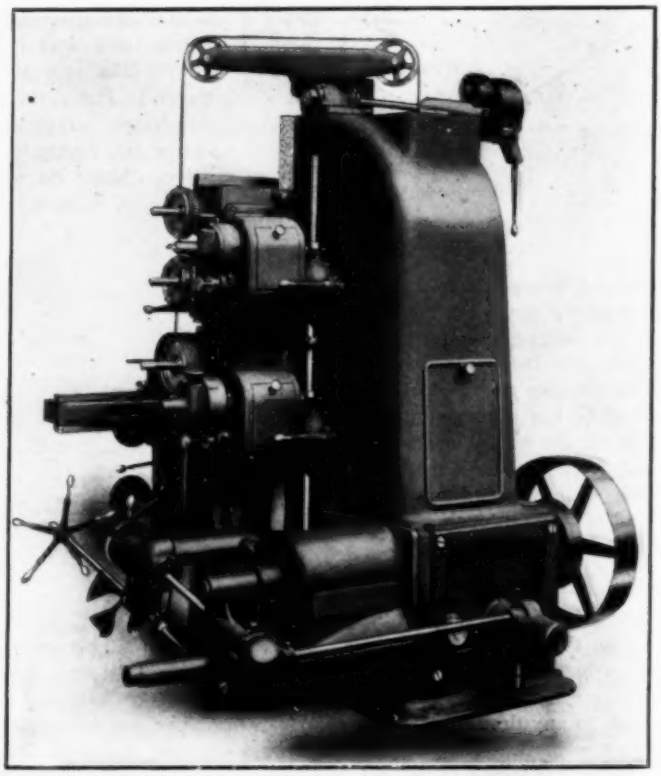


FIG. 1. FRONT AND REAR VIEWS OF VERTICAL TURRET LATHE FIG. 2

saddles have broad bearing surfaces in contact with their respective rails; they are gibbed to the long, narrower guiding portions of the rails to insure a smooth sliding action, while an additional gib is fitted at the back of each rail near the edge opposite the saddle guide to insure against any possible twisting of the saddle away from its seat on the rail. The side rail is firmly attached to the main-rail casting, and the latter is gibbed to the column, on which it takes a long bearing, the vertical movement of the two rails being accomplished by power independently of the table drive. Before describing the construction and operation of the two heads, it may be well to refer to the main driving mechanism for operating the table, from which the motion for the feed drive is derived.

The Table and Its Driving Mechanism

In Figs. 4 and 5 horizontal and longitudinal sections are presented showing the table and a portion of the driving gearing. As will be seen, the table takes a bearing in a broad conical seat, and the spindle, extending downward, has at each end a cylindrical bearing of large diameter. Ample lubrication is maintained by means of a sight oiler, into which lubricant is poured until it reaches the proper level, as indicated in the oil cup. The conical seat is thus kept flooded with oil, and the annular channel in which the seat is located acts as a reservoir from which the lubricant is steadily supplied to the spindle bearings under the table.

The table is rotated by a spur gear which is driven by a pinion on a short vertical shaft, the latter being connected by bevel gears with a longitudinal shaft which may be driven at fifteen different rates of speed by means of gears controlled by frictions and sliding keys. Referring to Fig. 6, which shows the speed box proper, five gears will be noticed, secured to the driving shaft *A* passing through the upper part of the box, this shaft being placed transversely of the machine. Meshing with these gears are five others which are

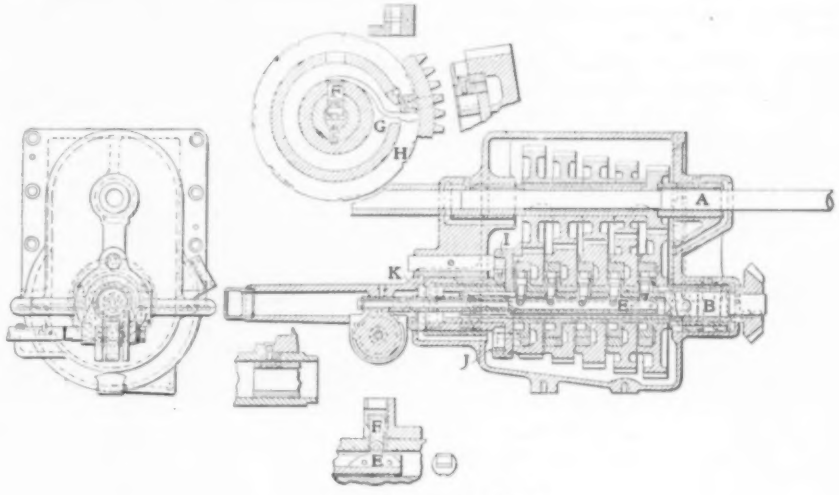


FIG. 6. SPEED BOX

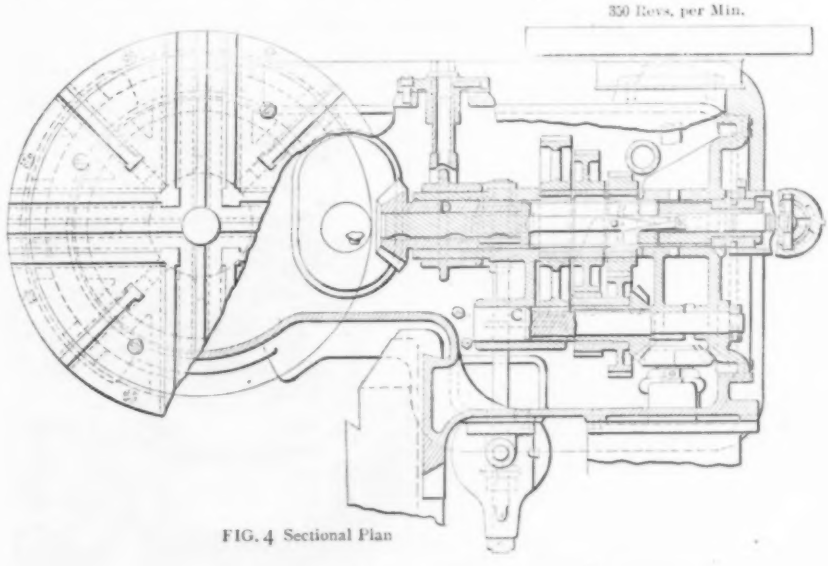


FIG. 4 Sectional Plan

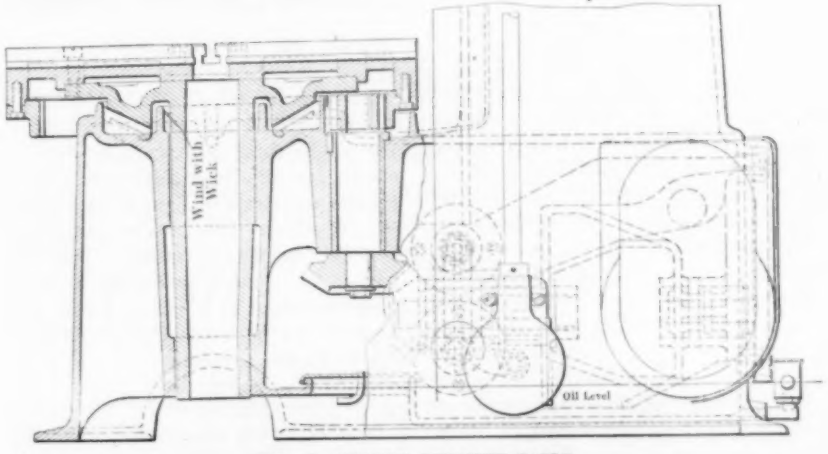


FIG. 5. SECTION THROUGH TABLE

normally free on their bearings, but any one of which may be connected by its friction ring to the lower shaft *B*; thus five speeds for this shaft are obtained from the constant-speed driving shaft above. The shaft *B* is connected by bevel gears with shaft *C*, Fig. 4, and the three spur gears on the latter shaft mesh with three loose gears which may be connected by a pair of sliding keys with shaft *D* for operating the table-driving pinion. Thus the five speeds imparted to shafts *B* and *C* are multiplied by three, giving the fifteen rates of speed for the table. It may be mentioned here that the lubricant required for the gearing in the bed is supplied from the sight oiler shown at the rear of the base in Fig. 2.

The Speed Control

The sliding keys just referred to, in shaft *D*, Fig. 4, are forced apart and into their seats in the gears by a spring, as shown. There are three pairs of seats or slots, so that the keys engage the proper gear quickly (in one-sixth of a turn or less) and without shock to the mechanism. The keys are pivoted at the end of a sliding plunger, the outer end of which is formed into a cylindrical rack meshing with a pinion which is operated by means of a pair of shafts placed at right angles at the side and back of the machine base, as illustrated in Fig. 2, the operating shaft being turned to any one of the three necessary positions by the handle and disk at the rear of the pilot wheel which operates the friction in the five gears in the speed box, Fig. 6.

The constructions of the frictions will

be clear upon inspection of this sectional drawing and the details, which are to larger scale. As the sliding plunger is drawn through shaft *B* by the rotation of the pilot wheel at the side of the machine, a cam or wedge-shaped shoe *E* lifts the spring plugs in the friction hubs encircling shaft *B*, thus opening the friction band in any required gear on the shaft and locking that gear to the shaft. As shown in the detail above the gear box, the operating plug *F* acts upon the end of a stiff spring lever *G*, rocking this sufficiently in its seat between the ends of the friction band *H* to open the latter and cause it to grip firmly the finished surface forming the friction seat under the rim of the gear. The means for adjusting the friction will be obvious from this detail. It will be noticed also that the operating lever *G*, being adapted to spring slightly at its inner end, serves as a compensating device for applying a constant pressure to the friction bands whenever the operating plugs *F* are forced into action; this definite pressure is thus maintained without minute adjustment of the operating members.

The friction device at *I* acts as a brake by which the table may be stopped at any desired point. In this case the expanding friction ring *J* is kept from rotating by a stud in the casing and is opened to grip the disk *I* by a slight rocking movement of quill *K*, which operates a finger working between the open ends of the friction ring.

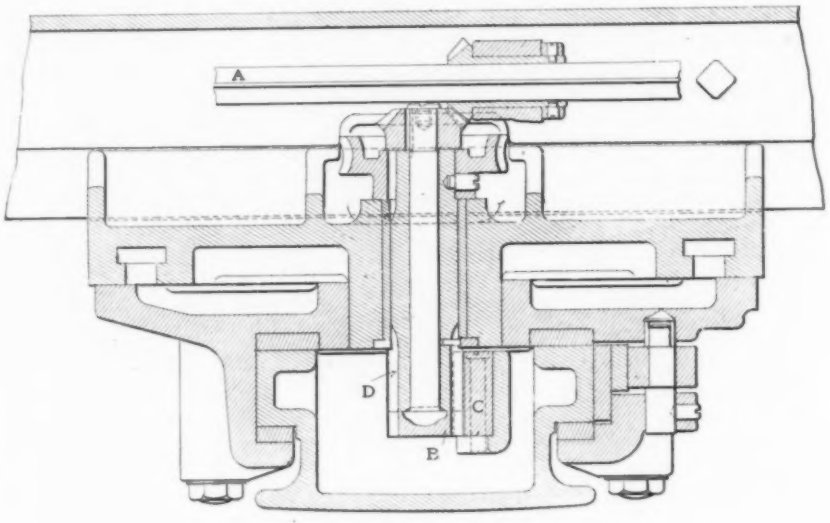


FIG. 8. SECTION THROUGH HEAD AND SADDLE

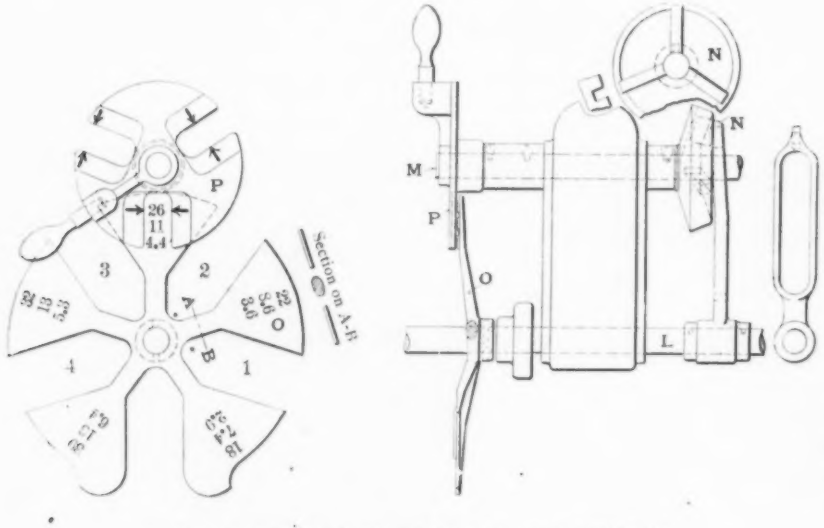


FIG. 7. INTERLOCKING DEVICE AND SPEED INDICATOR

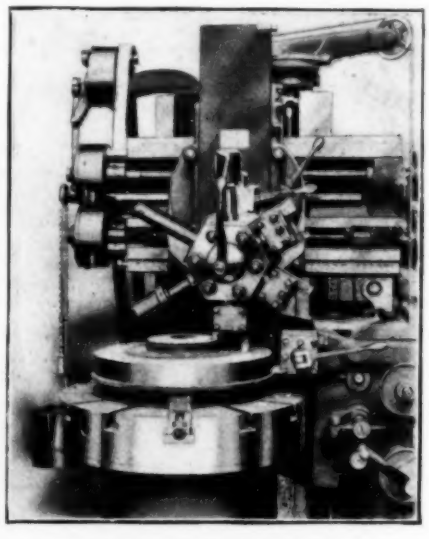


FIG. 10. FACING AND TURNING

The Interlocking Device

The sleeve *K* is the pivotal point for the pilot-wheel shaft *L* which controls the series of frictions in the gears in the speed box and applies the brake when desired. It will be clear from what is shown in the half-tones Figs. 1 and 2 and in the line engravings Figs 6 and 7 that the pilot wheel and its shaft *L* may be turned through nearly a complete rotation to bring into action any one of the five sets of gears in the speed box, Fig. 6; but the other shaft *M*, Fig. 7, which controls the three sets of gears inside the base, Fig. 4, can be operated only when the pilot wheel is lifted to release a locking device which is seen at *N*, Fig. 7, and also shown in the rear view of the machine. This lock, furthermore, can be released only when the pilot-wheel shaft is turned to a position where one of the four openings 1, 2, 3, 4 in the indicator plate *O* is opposite the shaft *M*. When the indicator is in one of these four positions, the sliding wedge or cam *E*, Fig. 6 in the driven shaft in the speed box is midway between two of the operating plungers for the frictions, leaving all the five gears disconnected from their shaft. Now the pilot-wheel shaft may be lifted, applying the brake and releasing the lock on shaft *M*, which may then be turned by the handle on notched disk *P* to shift the pair of spring keys controlling the three sets of gears for shaft *D*, Fig. 4. The shaft *M*, upon being turned to any one of its three positions, is again locked fast when shaft *L* is dropped to its original place. With the indicator set at the point shown in Fig. 7, the gearing gives the table a speed of 26 revolutions per minute, the outer circle of figures on the dial showing a range from 18 to 39 revolutions. When disk *P* is turned to the right one notch, five speeds from 7.4 to 16 revolutions per minute are obtainable by turning the pilot wheel, while with the third setting of disk *P* the range of speeds obtainable is from 2.9 to 6.4 turns per minute. In whichever of the three positions the disk *P* is set, the arrows at the sides come directly opposite the circle of figures on indicator plate *O* which show the speeds derived with that particular setting. The speed changes are quickly made, the operation being facilitated by a spring detent which supports the pilot-wheel shaft while the disk *P* is being turned.

The Two Turret Heads

Both heads on this machine are fitted with taper gibs, and positive alinement

may be maintained. The heads are counterbalanced, as indicated. The method of counterbalancing the main head is shown in Fig 8. The square shaft *A*, which carries at its left end a sprocket for the counterweight chain, maintains through a pair of bevel gears and pinion *B* a constant lifting action upon rack *C* to offset the weight of the turret and slide. The greater part of the width of this rack is engaged with the teeth of the pinion *D*, which feeds the head up or down or obliquely, the pinion shaft (which is of course central with the swivel head) being hollow to allow the counterbalance pinion shaft to pass through freely. Whether the head is set vertically or at an angle, it is thus neatly balanced.

In addition to the feed and counterbalance mechanism, the drawing gives a good idea of the proportions of the head and the method of arranging the gibs to maintain correct alinement of the slide.

The Feed and Quick-traverse Mechanism

The feed drive for the two heads is transmitted from the table-driving shaft by spiral and bevel gears and a vertical shaft shown at the rear of the feed boxes in Fig. 2. The gears in these boxes drive the feed rods and screws through worm and spiral gears and give eight changes of feed for each head, ranging from 0.0104 to 0.5 inch per turn of table. The feeds are all readily controlled by levers at the front. The indicators on the dials enable the tools to be fed to the exact points required for duplicating any desired number of sizes on a line of work. On the side head, besides the regular power and hand feeds, there is provision for applying a forming attachment for use in crowning pulleys, or turning other shapes on the periphery of the work.

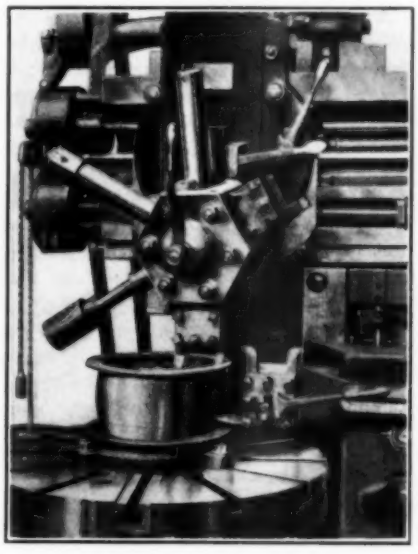


FIG. 11. A PULLEY JOB

The worm wheels for operating the feed screws and rods, as shown in Fig. 9, are gripped between the friction disks enabling the feed drive to slip in case of accident and thus prevent breakage. The handles *E F* at the side of the work gears control the quick-traversing device for moving the main head along the rail and the turret slide up and down. The drive for the quick traverse is taken from the belt that operates the power-elevating mechanism for the cross rail. This belt drives pulleys *G* and *H*, which operate two sets of friction-controlled reversing gears in boxes *I* and *J*. When handle *E* is turned to the right, plunger *K* operates the right-hand friction in box *I*; the corresponding gearing then drives the cross-feed screw rapidly in the proper direction to run the head to the right. When the handle *E* is turned to the left, the opposite gears in box *I* drive the feed screw and traverse the head to the left, or toward the center of the table. Similarly the vertical traverse of the head is controlled by the movement of handle *F*. The details given on the drawing will make the arrangement of the gearing, frictions, etc., clear to the reader.

It may be stated in connection with this drawing that member *L* is a pivoted stop that enables the main head to be set central with the table. When this stop is swung out of the way, the head may be fed a distance of four inches past the table center.

Figs. 10 and 11 show operations of turning, facing, etc., on two different classes of work, with interesting tool equipments. The tool shanks carried in the main turret are slotted at their rear ends to slip over pins fitted crosswise of the turret holes; when slid back over these pins the tools are held securely against twisting, without the necessity of setting up the binder bolts tight. When it is desirable to turn the tool holders, they may be drawn out slightly to clear the locking pins and then clamped tight by the regular binders.

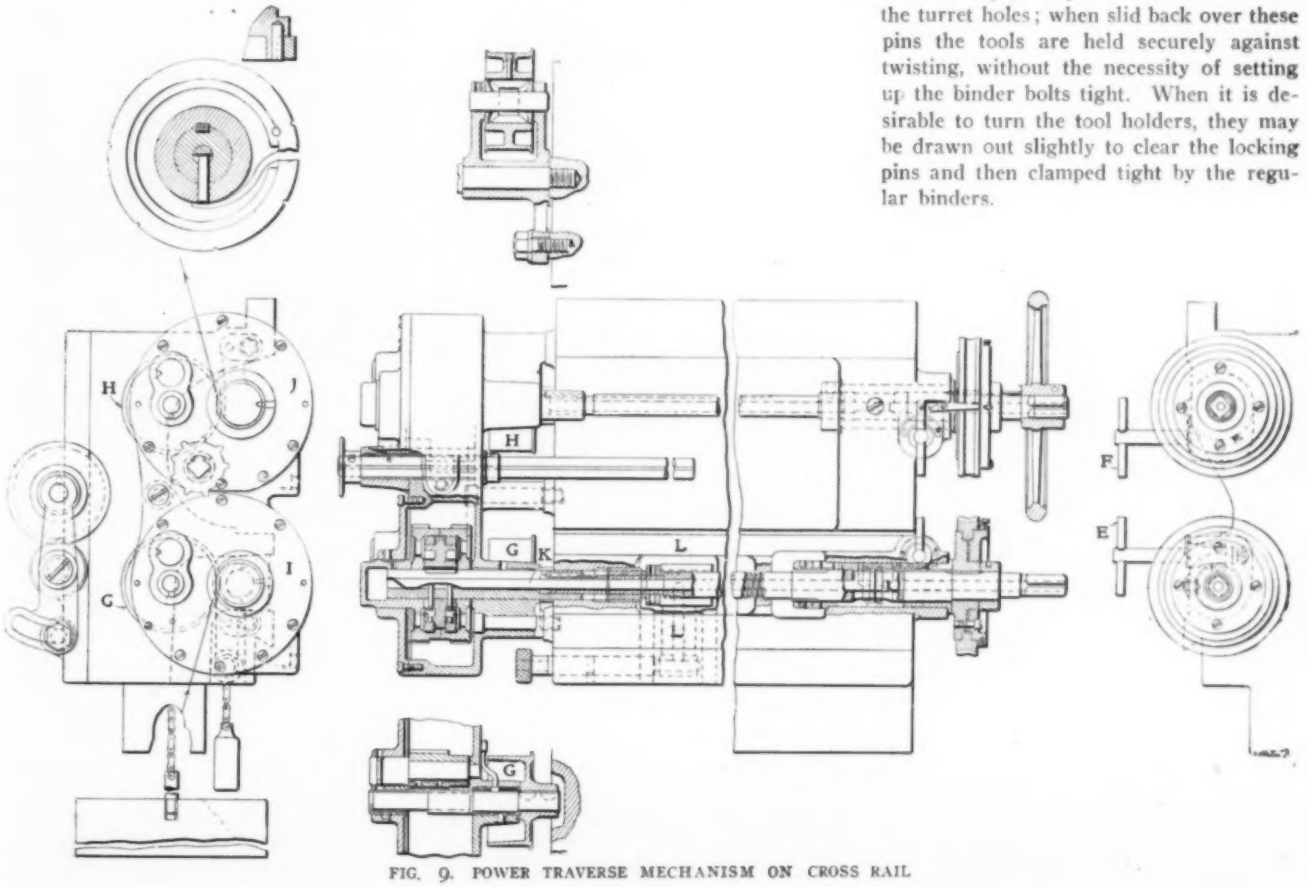


FIG. 9. POWER TRAVERSE MECHANISM ON CROSS RAIL

Some Memories of English Gears

By W. H. Booth

If anyone will examine the wheel teeth in some watches, he will find two very different shapes. Some of the teeth are curved from the root to the point; others are simply radial flanks with the top rounded off and have practically no length beyond the pitch circle. These teeth are generated by a rolling circle of one-half the diameter of the pitch circle of the radial flanked wheel. Such a generating circle rolled inside a pitch circle describes a diameter of the pitch circle with any point on its circumference which starts upon the pitch circle, and thus it draws radial flanks. If the generating circle is greater than one-half of the pitch circle, it will draw teeth more or less undercut; if too small a generating circle is employed, the teeth generated will flare out too widely at the root, and the tendency will be to thrust apart the wheels.

The early watchmakers spent a great deal of study on teeth. The science of the matter was put to them in book shape by Comus, a French writer, in whose book these various clock teeth will be found represented and their method of delineation explained.

But many of the early British millwrights had no notions whatever of science in respect to such matters as wheels and correct gearing. They evolved certain forms and proportions of teeth as a result of experience and observation. It is probable that owing to the use of wooden teeth in one of a pair of wheels any departure from a proper form was compensated for by the wear of the wooden teeth to something like a correct form to mesh with the mating wheel. The writer has heard it said and seen it stated that wrongly constructed teeth will never wear themselves right. This is not the case, however, for I have found numerous cases in practice where a long-toothed wheel or pair of wheels have worked together for years with the teeth not more than three-fourths or two-thirds of their depth in contact. Well attended to, properly greased and fairly prime to each other by means of a hunting tooth, these wheels have worn to shape so as to produce a perfect tooth upon the old, imperfect, long-faced teeth as originally made. In Fig. 1 the corrected form is shown cross-hatched upon the original outline. While wheels were wearing into true form they would be very noisy, and when thus worn there was, of course, a great deal of backlash.

The old millwrights, in order to prevent backlash in the gearing of a mill, made the rim velocity of the engine flywheel higher than that of the periphery of the millstones. All of the teeth made by the old millwright fraternity were very long. In some cases they exceeded the pitch. The idea was that a large number of teeth would be in mesh at the same time. But this was a very doubtful assumption, for the irregularities of new wheels were such, that there was no chance of several teeth all bearing at once. With a hunting cog and time, if a wheel lasted through its days of initiation, it did wear to a correct pitch all around the circle, and such wheels finally ran quietly. They were, however, a mistake and better counsels in time prevailed so that, probably owing to the influence of Sir William Fairbairn, the length of tooth was finally fixed as three-fourths of the pitch.

Fairbairn was the first of the good modern millwrights. He found heavy square wooden shafts running at low velocities. He introduced quick-running wrought-iron shafting and he built some of the finest examples of the architectural variety of beam engine that were ever seen; notably those at the India mill, Darwen, and at Salt's factory at Saltaire. Fairbairn introduced the direct spur drive; that is to say, the fly-wheel fitted in its rim with toothed segments. He seems to have employed teeth of a length of three-fourths of the pitch quite early. But everyone did not follow at once, and many millwrights continued to make teeth very much longer.

All toothed wheels were cast from wooden patterns, and the possession of a large stock of these patterns meant business. Every man who had any stock of patterns had them fully cataloged and the list distributed to his customers. In this way he often obtained work, especially if some of his patterns enabled some piece of break-down work to be repaired. If a firm failed or went out of business, its wheel patterns were pretty sure to be purchased by some other firm to swell its list. As every man made wheels on a different system, some of the pattern stocks were very heterogeneous. There were numerous odd pitches, as wheels of so many teeth had sometimes been made to fit between shafts of very casual distance apart. Then, as all the patterns were hand made, there was a tendency perhaps in some cases to make wheels of even diameter, and the pitch was necessarily fractional.

There was no clear understanding in regard to what pitch meant. Plenty of men understood that it was the distance from tooth to tooth as stepped with a pair of compasses. That is to say, they measured the chordal pitch and made wheels of different diameter to this dimension. Needless to say, such wheels were very noisy. They failed to realize that the primary idea of toothed wheels was a pair of plain cylinders rolling on each other and therefore describing equal lengths of arc in the same time. Teeth were merely surface projections put there to prevent the surfaces of the cylinders from slipping on each other. But, this primary principle was lost in the false idea of chordal pitch.

In the works where I was when a boy, we had a very large list of wheel patterns and a wheel patternmaker who thoroughly understood the principles of the art. We also had an excellent dividing engine on which patterns were cut by means of a shaped cutter, like a wood-molding cutter, set in a vertical spindle. The wheel was fixed on a vertical face plate carried on a spindle, on the other end of which was a carefully cut wheel of 360 teeth. This was about 42 inches in diameter. It had various change gears and a train of wheels for turning it through any desired angle by means of

FIG. 1.

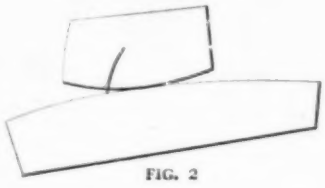


FIG. 2

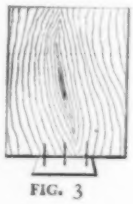


FIG. 3

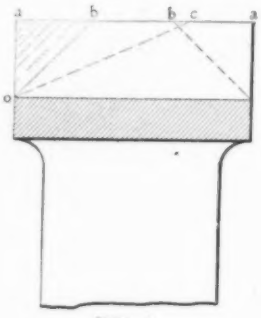


FIG. 4

FIG. 5

SOME MEMORIES OF ENGLISH GEARS

a handle and a notched quadrant. This was very slowly worked so as to avoid lost motion, and for most purposes several teeth in the large cut gear were involved in the indexing for one tooth of the cut pattern. The machine was well made by Colliers, of Manchester, and did very accurate work. The wooden patterns were practically perfect, and as they were smoothly finished and varnished, they drew with very little rapping. The cast wheels were also accurate.

The form of tooth was generated by rolling together two flat wooden curves upon a sheet of finely sandpapered tinned plate. The curves were about 3/8 inch thick. One of them had attached to it a brass carrier holding a vertical point of steel. The point was located in the edge of the rolling templet by cutting a notch so that the steel point could be made to coincide exactly with the lower edge and the circle. Pressed firmly together on the tinned plate and rolled together, the scriber drew the curve, as in Fig. 2, upon the tin plate. This served as the templet for the cutter, which, as in an ordinary gear-milling cutter, was made to the shape of the spaces and carefully honed to a keen edge. The teeth were made of baywood mahogany in rectangular blocks glued and sprigged to a dovetail piece, as in Fig. 3. The dovetail was tapered in the direction of its length and the block was curved to the wheel-rim radius. The rim had a correspondingly tapered dovetail and the teeth blocks were glued and firmly driven in. They projected slightly beyond the rim at each end and were trimmed off after setting.

Time was always given for timber to season and for glue to dry before any further operations were performed. The best patterns were the old stagers, which were stripped of their teeth, their bodies repaired and re-glued and fresh teeth fixed and cut. There was no further warping possible with patterns that had been years in stock. Patterns were painted with red lead and varnished with copal.

Most patternmakers put in a circular arc to join the flank or base of the tooth to the rim. These were often of so flat a radius that the point of the tooth of the opposite wheel would touch this fillet. The correct fillet should be described by rolling together two circular templets of the diameters of the two wheels. To one is attached a projecting point, which projects slightly farther than the back point or edge of the tooth. The hollow of the curve which this point describes is the proper form of fillet and forms the round corners of the wood cutter, with which the teeth of the patterns are cut in the dividing engine.

In the course of studying actual wheel problems one begins to see the futility of many of the things that used to be done, and that passed for good practice until looked into. Thus teeth were always finished with a square corner at the top of the point or face curve. This always had been sharp, a simple junction of the scribed face curve with the flat top of the tooth. All other corners in machine making were properly rounded. After some discussion the patternmaker agreed with me that this sharp edge should be taken off. It was some years after this when, after living at the antipodes, I came back and found that this sharp edge was now actually being rounded off.

We also agreed that a very slight degree of barreling of the working faces of a tooth would be correct practice, for it would eliminate the dangers that might arise with perfectly straight teeth when the shafts got a bit awry. We thought that a minute degree of barreling would at least prevent all the pressure from coming at once upon the outer top corner of a tooth if the wheels got out of parallel. The difficulty was to get the form. It could only be obtained from a two-part pattern drawn from the sand each way, or by a middle-parted flask. So we abandoned this theory as impracticable. But we found ideas for securing the same effect with less of the pattern in the cope. We proposed to shave off the corners of each tooth, as shown by the dotted lines of Fig. 4. All rules as to strength of teeth assumed that all the pressure came upon the corner *a* of one tooth and broke the tooth along the dotted line. No doubt such was the case and teeth did break very often along this line. We argued that if this line represents the maximum strength on which one can rely, why make the breadth of a tooth any greater than the length indicated, which is 1.41 times the tooth length, if it is supposed to form an angle of 45 degrees.

We argued that by slightly reducing the teeth on the corner *a* and toward the breakage line, any breaking stress is really transferred to the point *b*, and the tooth struck at *b* would only break off along the second dotted line *o c*. Thus in place of having *o b* equal to the maximum useful breadth of tooth we have *o c*. The ordinary breadths were really excessive, for they could not strengthen a tooth which might fail along *b*. The necessary shaving off was very little indeed, but it would prevent pressure from getting upon the point *b* until years of wear had made the teeth perfect. It would be necessary to have the triangle *o a b* in the cope in order that the pattern might draw, but no more than this shaved-off corner need be molded in this way and as it is small it would draw easily.

Fig. 5 shows the rolling of the flank inside the hollow pitch-line curve of a wheel. Much discussion has always arisen as to the proper diameter of rolling circles. In clock work where the flanks of all wheels were radial, each wheel point was described from a circle of half the diameter of the opposite wheel. The rolling circle which described the flank curves or root curves were the same circles rolled inside their respective pitch lines and therefore drawing radial lines. Then it was found by some mathematical man, who had perhaps never seen a tooth, that one circle would draw both points and flanks of every wheel in a set so that they would work together perfectly. But since a rolling curve of half the diameter draws radial flanks, and undercut flanks were held to be bad practice, the rolling curve diameter became fixed as the half diameter of the smallest wheel in a set. It is not held that wheels are quite as good when all are made from one rolling curve, but there was no other way of getting a number of wheels of different sizes to work together correctly. There is no absolute impossibility in regard to using a rolling curve of a diameter greater than the semi-diameter of any wheel, but the teeth become unduly thin at the base.

The involute form of tooth, once common, rather dropped out of use for heavy mill gearing as the cycloidal form came into more extended knowledge. It had, or was supposed to have, the disadvantage of considerable thrust upon the bearings as the slope of the teeth forced the wheels apart. But this is doubtful. It has the advantage that there is no fixed pitch line and wheels work together correctly at any depth of meshing, whereas cycloidal teeth must be set on the pitch line. Involute teeth have no fixed pitch line, but the line of contact of the teeth passes through the line of centers of the wheels, at a point always proportional to the number of teeth in its distance from each center. The velocity ratio is always correct, which is not the case with cycloidal teeth unless geared exactly to the one determined pitch line.

After a time the multiplicity of wheels caused the molding machine to be invented. This machine required only a pattern for a tooth space to be attached to a revolving arm. The arm was moved for each tooth space which was rammed, and through one tooth angle. Lost motion was apt to creep in one way or the other, and very irregular pitching and consequent noise ensued. There was a tendency to make molded teeth too full on the pitch line, so that at first they had a very narrow contact breadth and actually wore hollow about the pitch line.

A well made pattern wheel was not perhaps to the exact scribed curve, but slightly full at the pitch line so that wear did not extend all the way over the teeth when they were new. Such fullness we saw could not safely be made large or wear became severe. Later molding machines do better work, but in all such machines care is required to eliminate lost-motion faults.

Milling Attachment for Large Boring Mill

A very interesting milling attachment was recently made and used by the Bethlehem Foundry and Machine Company, South Bethlehem, Penn., for milling off the pads on the side of the hopper shown in position on the boring-mill table, the hopper being so large that it could not be handled on the boring mill or on any planer in the shop.

As will be seen in Fig. 1, the whole milling device is held in the end of the right-hand tool slide, the top plate of the attachment being clamped tight against the end of the slide. Dovetailed to this so it can be moved across the plate by the hand wheel and screw shown, is the body of the device, which also carries the motor on the lower end of the frame.

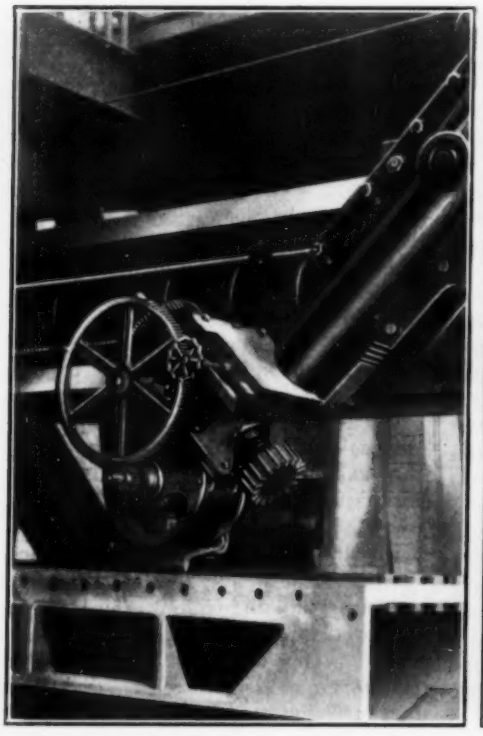


FIG. 1. THE MILLING ATTACHMENT

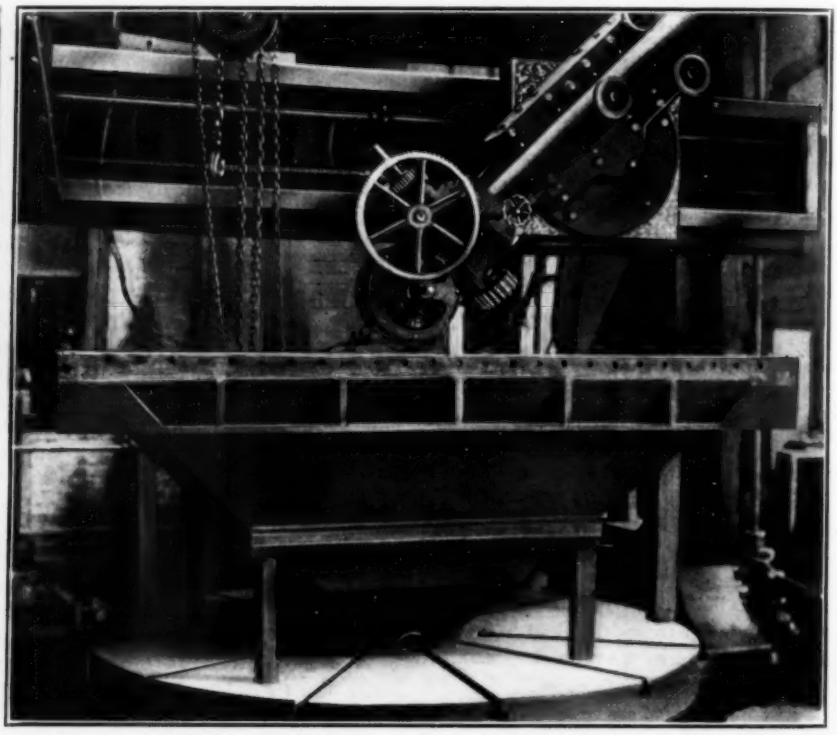


FIG. 2. THE WORK AND ATTACHMENT IN PLACE

This motor drives the large gear, and the milling cutter receives its motion through bevels and the spur gears shown. The mounting of the motor in this way enables the whole milling attachment to be swung at any desired angle or moved to any point on the cross rail without any difficulty whatever. Add to this the movement of the table carrying the work and the ability to turn the whole milling device at right angles or any other position, and you have a combination that can handle almost any class of work that comes along. By placing the work so the cut to be made is parallel with the cross-rail, power feed can be used and a long cut taken, as in the case of the hopper shown in Fig. 2.

It is a substantial device as well as being very flexible, and we believe it will be found useful in many cases that come up in such a shop. By means of an angle plate the machine was used in milling off flanges on the top and sides of the hopper.

We are indebted to the general manager, J. G. Lehman, for the photographs and information concerning this attachment.

Road improvements in Athens, N. Y., have not found favor with the conservative majority of its people, and the progressive element considered strong measures necessary. One morning the center of the town's leading thoroughfare was found planted with several rows of cabbages. The town council was stirred to action and consulted a local inventor as to what should be done. He decided that the street had a gravel bottom and by pouring tar on it a good pavement would result. He was so confident in the success of the method that he offered to furnish the labor if the council would supply the tar. Two blocks were covered in this way on the first day, but the conservatism of the town revolted and the next morning the street was found coated with feathers.—*Engineering Record.*

The production of denatured alcohol for the first six months of 1907, under the new law, was 1,774,272 gallons. The supplemental free alcohol law will, it is estimated, lead to the production of 4,000,000 gallons for the calendar year. The operation of the law reduced the cost of wood alcohol from 60 to 30 cents a gallon, which has greatly benefited consumers.

How to Select Direct-current Electric Motors for Different Kinds of Service

By C. C. Stutz

It is sometimes a question as to what type of electric motor is best for a given condition of work. To aid in making such a selection I will give a few short rules for the simpler forms of direct-current machines.

Series-wound motors should be used for heavy loads and variable speed.

Compound-wound motors should be used for heavy starting load and fairly constant speed.

Shunt-wound motors should be used for light starting load and constant speed.

Notes:

A series-wound motor with its high starting torque makes it possible to obtain a rapid acceleration under load, as in railway work.

A compound-wound motor will vary in speed about 10 per cent. between no load and full load, slowing down under full load.

A shunt-wound motor will give a nearly constant speed for variations in load as long as the potential of the current supply is constant.

A change of speed may be produced by varying the strength of the magnetic field; the weaker the field the higher the speed.

Motors may be overloaded 25 to 50 per cent. for short periods, provided the intervals of rest are sufficiently long to allow for cooling.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

An Arc Planing Attachment

I was asked to design a machine on which the sliding surfaces and tongues of the bed plates and draw heads of the Brooks cold tire-setting machine could be planed. These parts are made of steel castings, tough and sandy. Figs. 1 and 2 show the attachment on the planer, with a bed plate in place being machined. The line cut, Fig. 3, shows the general arrangement of the device.

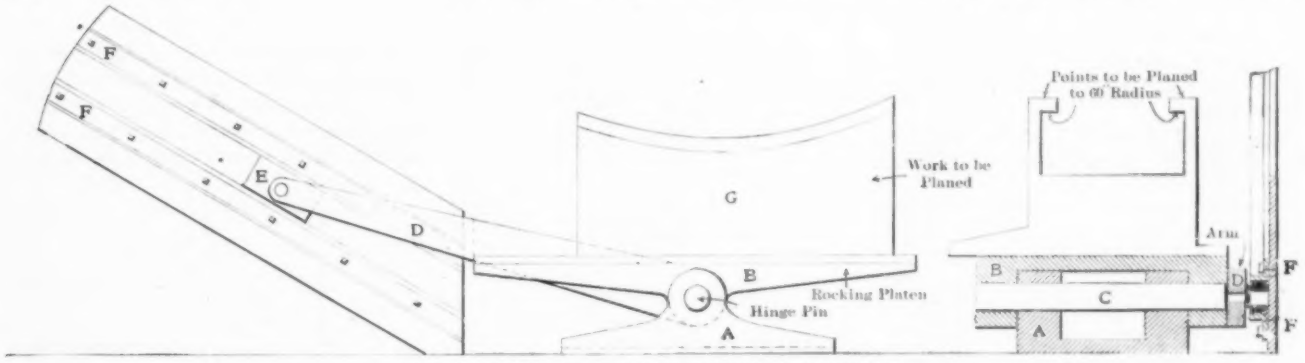


FIG. 3. DETAIL OF THE ARC PLANING ATTACHMENT

A is the base of the attachment bolted to the table of the planer. A rocking platen *B* is mounted on a pin *C* in the base. A lever *D* is fastened to each end of the pin *C* (only one being shown) and a sliding block *E* is pinned to the end of each of the levers. These blocks slide in the tracks *F* bolted to the planer housings, oscillating the platen as it passes the tool. *G* is the work to be planed.

W. E. JACKSON.

Making a Sub-press Die

I wish to add a little to Mr. Hyatt's article on page 255.

The housing, after being bored for babbitting, should be set up in the shaper and several keyways cut in it following the same taper. Care must be used to get these grooves in line with one another, and in line with the bore. The plunger *D* should also be handled with great care when grooving, so that the grooves will not be out of line or deeper at one end than at the other. After babbitting, it is a good policy to re-locate the housing in the lathe and cut a very coarse pitch thread, say one or three-quarters to the inch, in the babbitt for oil.

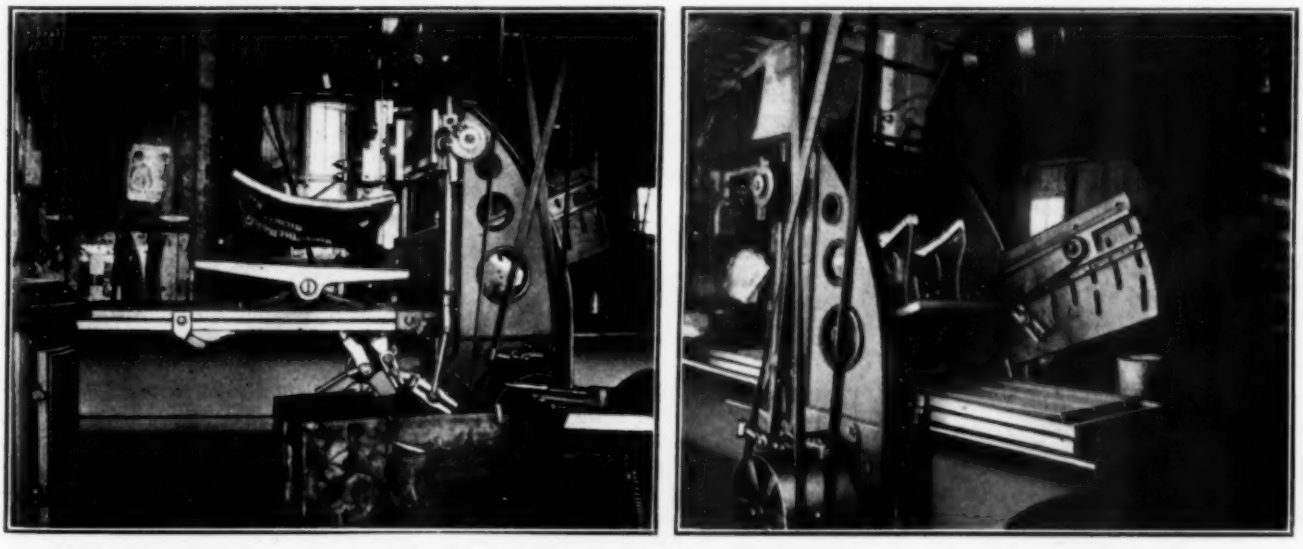
Scraping to a fit may be all right, but I believe the better way is to set up the subpress, at this stage, in the punch press and run it by hand or power, using plenty of oil and taking care that it does not heat enough to run the babbitt. I wish to state also that in use the punches are never allowed to enter the dies.

A. J. BRICKNER.

Speeds on the Grinding Machine

Mr. Noyes presents some interesting data on pages 256 and 257, but has he not made some fundamental errors in his method of interpretation?

On page 257 in the second column and in the paragraph beginning "In this table compare . . . " he says: "In 1 and 2 all conditions were the same except the traverse and the depth of cut. The increase from 0.5 cubic inch of metal removed per minute to 0.8 showed a distinct advantage for the slower traverse. . . ." As he has changed two important factors, he has no way of determining which of the two caused the variation in the results, or if the variation was caused by both together. In other words, he has violated the rule



FIGS. 1 AND 2. THE ARC PLANING ATTACHMENT APPLIED TO THE PLANER

of experimenting which states, "never change more than one variable at a time." The reason for the rule is plain.

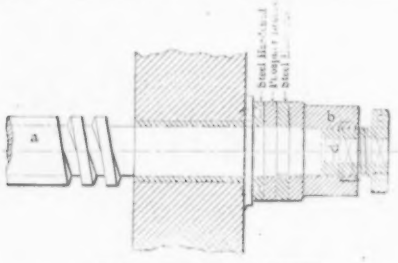
I should like to ask if the wheel wear was a decrease in diameter or in radius and how it was measured; also, if the depth of cut is reduction in the diameter of the work or in radius.

It would appear from test No. 11, in which the work surface speed is 9 feet per minute, the traverse 2⅛ inches per revolution, the depth of cut 0.030 inch and the cubic inches removed per minute 5.5, that the way to remove cast iron is to use a slow surface speed, deep cut and broad traverse. WILBUR C. SEARLE.

A Lock Nut That Locks

The lock-nut question has often been discussed in your paper but the following example is not common and may be of interest. The sketch shows one end of the driving screw *a* of a planing machine, the wheel for rotating it being preferably at the other end where there is a collar on the shaft.

The inner lock nut *b* is of the ordinary type (internally threaded) but made long



A LOCK NUT THAT LOCKS

enough to overhang the fine threaded portion of the screw *a*. The outer lock nut *c* is threaded externally and screws into the inner lock nut as shown. The end of the screw *a* is sometimes turned down at *d* to form a support for the outer lock nut, but this is perhaps an unnecessary refinement.

Now the ordinary arrangement of locking one nut hard up against the other has the obvious fault that the tighter the outer nut is screwed up the more it tends to force the threads of the inner nut off the threads of the screw, on the side on which the pressure comes upon them.

In the arrangement here shown the locking up of the outer nut tends to draw the inner nut close up against that side of the thread on which the pressure comes, and so decrease (or practically nullify) its tendency to become slack under vibration or the alternating loads set up on a driving screw whose direction of rotation and consequent end pressure are being continually reversed.

This form of lock nut was patented by Wicksteed (in England), No. 8149 of the year 1901, but the patent was allowed to lapse in 1905. The same idea was shown to me by a friend in 1897.

England. T. M. LOWTHIAN.

A Keyway Chisel and a Flange Wrench

The half-tone Fig. 1 and the line cut Fig. 2 show a chisel used for dressing up splines that have become worn.

In such machines as board trimmers the spline in the shaft becomes more worn in certain places than in others. This wear occurs of course on the driving side only,

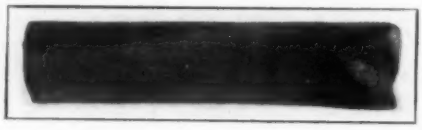


FIG. 1. A KEYWAY CHISEL

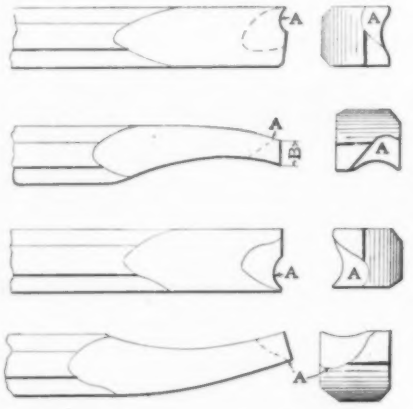


FIG. 2. VARIOUS VIEWS OF THE KEYWAY CHISEL

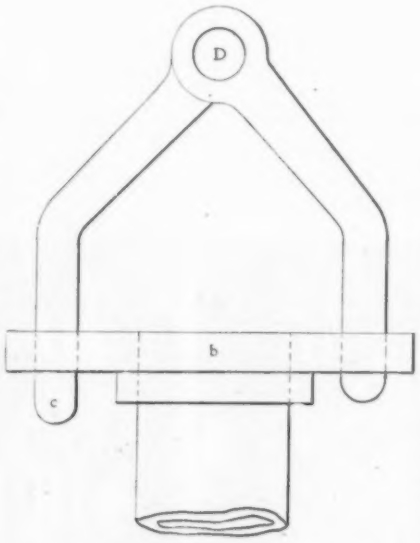


FIG. 3. TOOL FOR PUTTING FLANGES ON

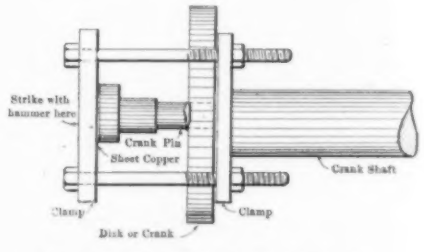
leaving the other side true. The width *B*, Fig. 2, is made the full width that the keyway is to be when finished. *A* is the cutting edge; all other edges are slightly rounded to prevent the tool digging in.

Fig. 3 shows a tool for putting on and removing threaded flanges. The two legs are loosely riveted together at *D*. One leg *C* is made slightly longer than the other, as this permits the tool to be entered more easily in the bolt holes in the flanges. A bar or pipe is then used for turning the flange. P. H. BURNS.

Putting in Crank-pins in the Field

It is my experience that in many cases engineers let their engines run for a long time after the crank-pin has become loose. They will rivet it up and expect it to keep tight, but in a little while it is worse than ever; all the time the hole has been growing oblong, which makes it all the more difficult to make it right.

Where you have good tools it is easy to do a repair job such as putting in a new pin. But there are some places where there is no boring bar to true up the hole, and then you must do the next best thing and get down to the file, scraper and emery, and get the bore as true as possible. There is a difference of opinion as to whether a pin should be put in cold or into the hole expanded by heat. I have



RIG FOR DRAWING IN CRANK PINS

put a great many pins into engines while on their beds, and I have always put them in cold and have never had one work loose. The illustration shows the rigging which I use in putting in a pin. In nearly all cases the crank-pins are wrought iron and the disk or cranks are cast iron. In my opinion, when a pin is put in cold the pressure in drawing in the pin makes the cast iron fluted, and it adheres or embeds itself into the wrought iron so that it is almost impossible for it to become loose. I usually make the pin the same size as the bore in the disk or crank; the power from the two heavy draw bolts and tapping on the end of the pin with a hammer will bring it to its place to stay, or, in shop expression, "send it home." It is well to take off the pedestal caps and take out the studs so that there will be no danger of bending them. Also cover the shaft with waste or canvas to keep off the dirt.

Some might think that it is impossible to get a pin in out of true. But such is not the case. It is well to have a try square and keep using it the whole time you are drawing in the pin. If the pin leans in one direction, pull the opposite nut until it is square and then try to pull them even to keep it straight. If it dips

up or down, drive it in the right direction by using a block of wood and hammer or a soft-faced hammer.

D. R. LLEWELLYN.

A Handy Counterbore

On page 564, Part 1 of present volume, there was a counterboring kink by M. Bode, which he used on ebonite blocks. With this class of counterbore or flat-bottomed drill he will have to use a guide plate or templet; otherwise he will have his drill roam a bit and doubtless will chip the top of the hole and spoil the job.

Here is a way in which he can do without a guide plate when counterboring. Take a piece of silver steel the size of the head of the screw that the counterbored hole is to take (this can be had within 0.004 either way); center and drill the size required in the lathe. It is best to drill from both ends and have the hole meet in the middle, as there is less risk of its being out of truth. Slit this at one end and on the other file or mill two flats, which will break into the hole. Then back off the two blades thus formed, and put in a piece of wire the size of the hole. The split end, being gripped in the chuck, holds both counterbore and pin, as in Fig. 1.

If his drilling jig is made so that the body of the counterbore enters the bushing of the jig and a drill is used in place of the pin, Fig. 2, you have a drill and counterbore all in one tool. It is obvious that where there is a large number to do, this must effect a great saving of time.

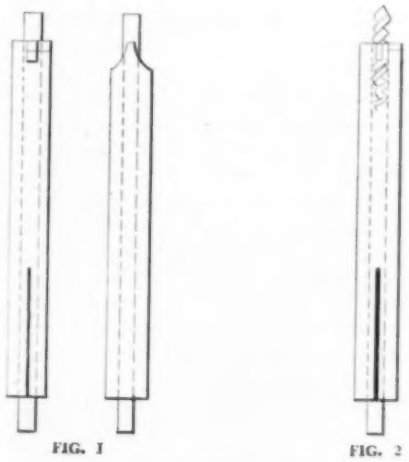


FIG. 1 FIG. 2

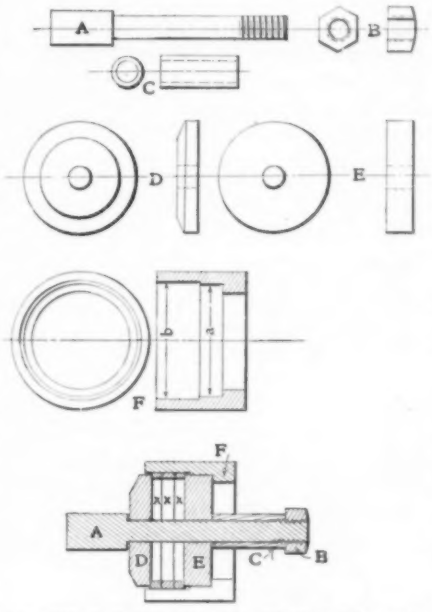
A HANDY COUNTERBORE

If used only in counterboring, the time is saved in not having to put on and take off the guide plate. It will be seen that this is very easily made, costs very little, can be quickly ground and set when dull, and can be used while it hangs together. Of course the shank should not be hardened.

England. J. V. H.

An Inexpensive Jig for Re-turning Piston Rings

A few months ago a hurry-up order came down from the superintendent's office for 36 re-turned piston rings of a special size. It fell to my lot to re-turn the rings. The foreman brought me the rough-turned rings shortly after starting work in the morning, asking me to do them as soon as possible.



AN INEXPENSIVE JIG FOR RE-TURNING PISTON RINGS

Having no jig for rings of that size, I rigged up one similar to the sketches, and succeeded in getting the jig together and the rings finished that forenoon. Sixteen of the rings were in a four-cylinder engine and it was running shortly after noon. The foreman took the "hurry-up" jig to the tool-room, remarking, "I guess we will save this; it does the work as well as an expensive jig and cost less than one-tenth as much."

In making the jig, *A* was turned out of 1¼-inch cold-rolled steel, the small part 1 inch in diameter and threaded at the end for the 1-inch nut *B*. *D* and *E* were heavy cast washers, *D* being faced and bored for a driving fit for the small part of the mandrel. They were forced tight against the shoulder on *A*. *E* was faced and bored a sliding fit for *A*. *C* is a filler or long washer made of 1-inch pipe to fill up the space on the mandrel between collar *E* and nut *B*. *F* was made from a piece of piston ring, blank bored at *a* to the size that the re-turned rings were to be, and bored 1/32 inch larger at *b*. Collars *D* and *E* were placed on mandrel *A* and turned on the outside to a free fit in ring *F* at *a*. To fill the jig with rings, place collar *E* in ring *F* at *a* and fill space *b* with rings properly cut in the joint; then shove all on the mandrel so that collars *D* and *E* face each other with rings between. Then put filler *C* against collar *E* and screw nut *B* on tight.

The cross-sectional view of the assembled jig shows three rings *X X X* between collars 4 and 5. They are held true by ring 6 until nut *B* is tightened up, when a blow of nut end of jig on a block of hard wood causes ring *F* to drop off over nut, leaving the rings securely fastened between the collars and set out just enough for the re-turning cut. By having two collars *E*, ring *F* can be refilled with rings while the lathe is taking the cut on the ones in the jig.

CHAS. T. GILBERT.

The Limit of Proportionality and the Elastic Limit

In a paper on ball bearings that I read before the American Society of Mechanical Engineers, at Indianapolis, June, 1907, the statement is made that "a limit of proportionality above the elastic limit is desirable." See also the abstract in the AMERICAN MACHINIST, page 297.

Prof. Wm. Kent asks the editor: "Do you know what he [the author] means by these two terms? They are sometimes defined as one and the same thing. How can the limit of proportionality be above the elastic limit?"

This statement is originally due to Professor Stribeck, who brought out the desirability of the relationship quoted in the course of his investigations of the broad field of anti-friction (rolling) bearings.

In asking Professor Stribeck for his

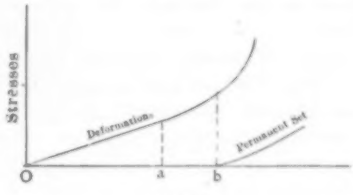


FIG. 1

FIG. 2

DIAGRAMS SHOWING THE LIMIT OF PROPORTIONALITY AND THE LIMIT OF ELASTICITY

definition of the terms elastic limit and proportional limit, I said that "I had always accepted the limit of proportionality as being different from the elastic limit, in that the former occurs at a point where the change in deformation is no longer directly proportional to the load, so that the line representing it becomes a curve

instead of a straight line, whereas the elastic limit is that point at which permanent set begins."

In reply Professor Stribeck refers to Herz's investigation and that the latter apparently assumes that the elastic and proportional limits occur at the same point. Professor Stribeck adds: According to my more recent investigations the proportional limit for the purely elastic deformations is materially higher than the elastic limit." In making a request for further explanation I wrote: "In so far as I understand general usage the proportional limit is at *a*, Fig. 1, i.e., the curve does not continue as a straight line beyond that point. The elastic limit is at *b*, i.e., here the curve sharply changes its direction. This point also indicates the beginning of the permanent set. Purely elastic deformations are those between *O* and *b*. Personally I always understood that the proportional and elastic limits were identical, but that the supposed difference was due to the inefficacy of existing measuring apparatus in permitting the recognition of the permanent set at *a* and therefore the real indentity of points *a* and *b*."

In reply Professor Stribeck stated: "Elastic limit is that stress at which a permanent set is definitely recognizable, using certain measuring apparatus. All stresses between zero and the elastic limit therefore deal only with elastic deformations. Beyond the elastic limit there occur permanent as well as elastic deformations, the two together giving the total deformation. Clearly the elastic deformations may be proportional to the stresses also beyond the elastic limit. This is clear from the sketch, Fig. 2. While the line of the total deformations is curved beyond the elastic limit, the line of the elastic deformations is a directly proportional continuation beyond the elastic limit; in other words, there is direct proportionality between the elastic deformations and the stresses also beyond the elastic limit. The limit of proportionality lies at the point at which the elastic deformation line begins to curve. With hardened steel the proportional limit for the elastic deformation is much higher than the elastic limit."

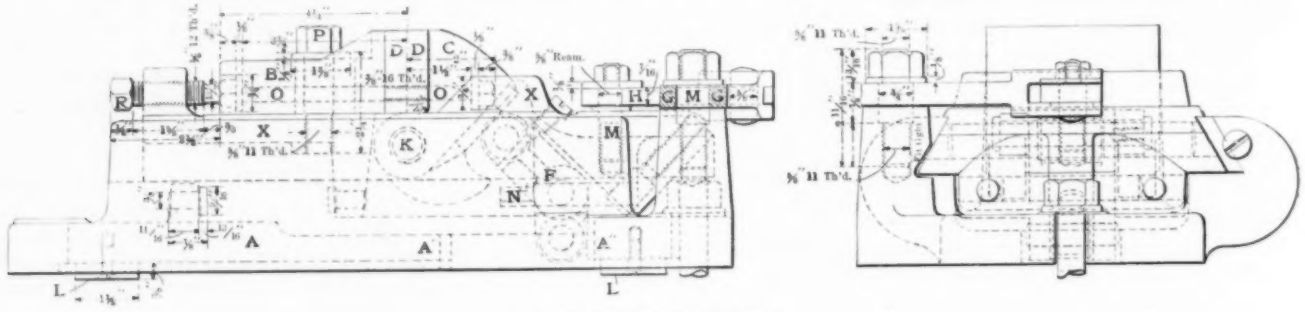
From the fact that in my need for an explanation I find myself in such distinguished company as that of Professor Kent, it may be fairly inferred that this complete statement of the results of Professor Stribeck's investigations may be welcome to others also; it therefore gives me much pleasure to proffer this explanation at the editor's request.

HENRY HESS.

An Automatic Milling-machine Vise

Having been in contact with and engaged in milling-machine work for a number of years, I am fully cognizant of how rarely one finds an automatic vise that is "worth the powder." Either they are only semi-automatic, or if fully automatic they are too complicated to be practicable, and will not stand up under the heavy service that is required of a vise in the milling-machine department of a large manufacturing plant.

We have, however, recently designed and put into the shop an automatic vise that so far seems to meet the demands made upon it, and which from its construction permits so quick, firm and accurate handling of the smaller work as to evoke some rather pleasing remarks from the foreman of this department.



AN AUTOMATIC MILLING VISE

The drawing shows two views of this mechanism, and in order that its working may be readily understandable I will go into a brief description of the parts and their uses. *A*, the cast-iron base, is slotted at each end, to take the usual platen bolts, and is also fitted with two machine-steel tongues *L L*, to fit into the platen slot. Stationary vise jaw *B* is also a casting, being fastened to the main-slide casting *X* by the screw *P*, and adjusted, and held in the position required by the screw *R*. The movable or swiveling jaw *C* is also a casting, and turns on the pin *K*, which is tapered to permit of adjustment for wear. The linings for these jaws, *D D*, made of machine steel and case-hardened, are, of course, made to fit the work that is to be handled. *O O* are four screws, two in each jaw to retain the pieces *D D* in place, together with dowel pins, which are not shown on the drawing. The bell crank *F* is a casting fitted with two shafts with machine-steel rollers hardened and ground and bearing against the under side of the rotating jaw *C*, and the ends of the slots in the base casting *A*, they are actuated by the movement of the slide *X*, as will be explained later. The lever is shown in cross-section at *G*, and is connected to the slide *X* by the link *H*, both of which pieces are pivoted on the shoulder studs *M M*.

The operation of the vise is as follows: The end of the handle (shown in section at *G*) is pulled to the right, causing the slide, with all the parts thereto attached to move to the left; the table of the milling machine, being locked in a suitable position, is not moved at all. When the slide has moved far enough to the left to bring the lower end of the bell crank *F* in contact with the base casting at *A*, this bell crank is forced to rotate on its axis, releasing *C*, which falls back by gravity, leaving the jaws open for the insertion of the piece.

To close the jaws and clamp the piece, the handle is moved to the left, bringing the slide to the right until the lower end of the bell crank *F*, comes in contact with the base casting at the point *A"*, causing it to rotate on its axis again and forcing it against the lower side of the rotating jaw *C*. As the steel plate on which the rollers held by the bell crank *F* work, on the lower part of *C*, has a slight taper, the pressure obtained is very great, and a firm grip is maintained on the work.

As it will be seen from this explanation that the jaws remain open on the return stroke of the lever and closed on the left to right stroke for a considerable distance, it is evident that if the cutters are placed midway over this stroke, the jaws will hold the work tightly while passing under them to the left, returning to the right open and ready for the insertion of another piece.

Stops are also provided for the limiting of the movement of the slide and the bell crank, but the use of these is self-evident and needs no comment.

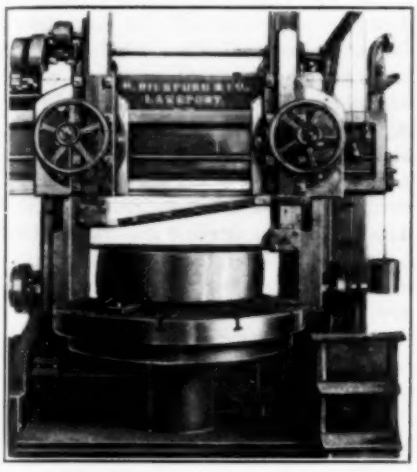
M. R. CRITTALL.

Pulley Crowning on Boring Mill

The pulley having been bored in the usual manner, the operation of crowning is performed by a connecting-rod, equal in length to the radius of the crown, one

end of which is clamped in the tool nead of the left-hand spindle, which is secured in position; the other end is clamped to the opposite spindle, high enough to clear the work as it is fed downward.

Both ends of this connecting-rod being jointed, it will be seen that after disengaging the feed screw in the right-hand head, the spindle and consequently the tool, will move out and in as it feeds downward. The joints in this rod were carefully

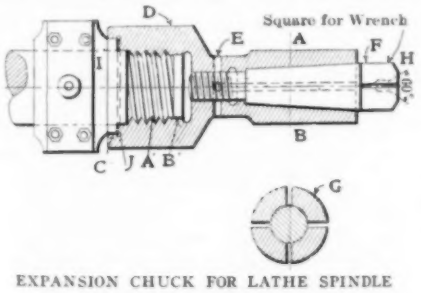


CROWNING A PULLEY ON A BORING MILL

fitted, as a very slight amount of play would cause a flat spot to occur in the center of the crown. The rod is adjustable for length so that pulleys of different size and radius of crown may be operated on. It is also evident that the radius bar should be so fastened that it will be level when the tool is at the center of the pulley. W. C. CHINNECK

Expansion Chuck for Lathe Spindle

The sketch shows an expansion chuck to be used on the engine lathe. *A'* represents the spindle nose. *B'*, *C* and *I* are the bearings for chuck. *J* shows a clear-



EXPANSION CHUCK FOR LATHE SPINDLE

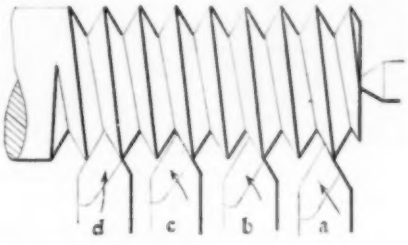
ance in the corner which is necessary to a good job. *D*, the body of chuck, is a steel forging. *E* shows the drill hole at the end of the slots. At *F* is the taper expander, taper 2 inches per foot. This may be made of soft steel and thoroughly case-hardened, then ground to bearing. *H* shows a 60-degree center. This should be made very large and have three oil grooves cut in it, as the tailstock center is used to steady the chuck while operating. *G* shows a section on line *A B*.

The special features of this chuck are found at *B'* and *C*, which center it every time. The lathe selected for this chuck should have collar *C* trued up (if not already true) and about 3 threads turned off at *B'*; at these places the fits should be perfect. Expansion bushings may be used in connection with it for a variety of work. The chuck is especially adapted to gas- and steam-engine as well as general repair work. M. F. PARSONS.

Cutting 60-degree Threads

In cutting V or 60-degree threads, the tendency of the tool to dig and tear the work is very great, especially on coarse threads. The method that I will describe, while not new to some, will possibly help many.

Work on the cutting principle of the side tool. To do this, swing the compound rest around to 30 degrees, one-half the number of degrees of the thread. Clamp and set the thread tool with the center gage the same as though the rest were square with the job. In cutting, the tool is brought to the same position for each successive cut on the cross slide and fed into the work with the compound,



HOW TOOL IS FED BY COMPOUND REST

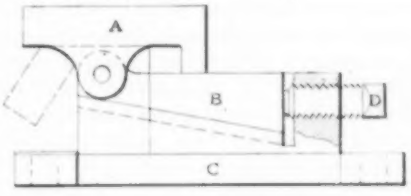
which makes all the cutting on the side. When nearly finished, a few light cuts should be taken, fed straight in with the cross slide; with the work revolving very slowly, a smooth, perfect thread can be obtained. Different positions of the tool are shown at *a*, *b*, *c* and *d*, and direction of feed in each case.

Another point gained by having the compound at an angle is, should the tool become dull when the thread is nearly finished, it is sometimes a little difficult to reset exactly where it was before, especially on internal work; but as it can be fed in and out on an angle, no difficulty is encountered. C. A. MARSTON.

[This can be used equally well in cutting a United States Standard flat top and bottom thread by having the point of the tool at least as broad as the flat required for the thread being cut. An Acme or any other angle could be cut in the same way by setting the compound rest right and watching the point of the tool.—ED.]

A Swivel Elevating Block

The accompanying illustration shows an elevating block with a swiveling top, which I recently made to use in slotting a quantity of pawls of various shapes and sizes. It consists of the base *C*, the sliding wedge *B*, the top *A* and the adjusting screw *D*. Its construction needs no explanation. It is a universal tool, can be



A SWIVEL ELEVATING BLOCK

used on irregularly shaped work and is adapted to a shaper, planer or miller.

J. OAKLEY.

L——, England.

Making Wooden Rolls for Textile Machiney

G. A. Dexter, on page 200, describes a way of making wood rolls for textile machinery that is very interesting to me, inasmuch as he accomplishes the desired end by methods entirely different from those which I employ on this class of work. I wish, however, that he would go a little farther and illustrate and describe the tool used for cutting out for the rings on his large rolls; give dimensions of the rings used; illustrate his method of counterboring the second end of the log with the shaft in place and projecting through the log; tell us how

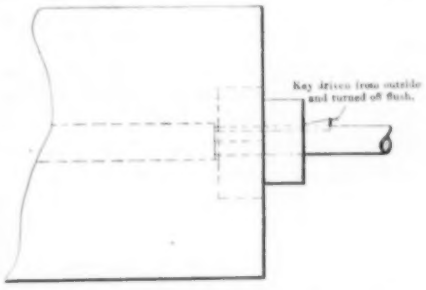


FIG. 1. KEYING THE SPIDER OF A WOODEN ROLL

much larger he bores his shaft hole than the size of the stock used for the shaft and what he uses to drive the shaft in with; and lastly, are his spiders a driving fit on the shaft? If they are, with his key driven in from the hub end after the second spider is in place, how does he remove them when making repairs by putting a new log on an old shaft? Fig. 1 will show the point I am referring to. I

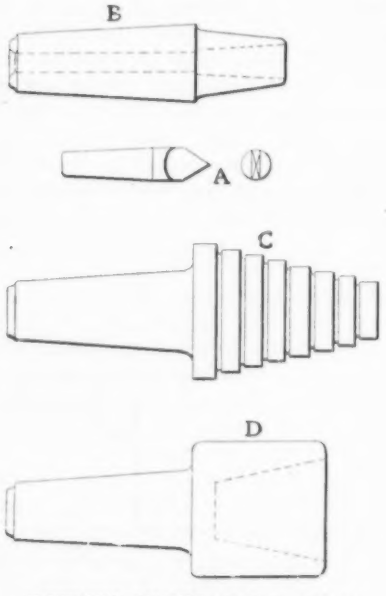
would also like to ask if Mr. Dexter has ever had any trouble with his shafts becoming loose in his "washer" rolls after running for a time, and which end of the roll seemed to bother him more.

L. L. ARNOLD.

Centering Polished Round Stock

We had trouble with our centering machine. It was all right for rough stock which had to be turned, but was no good for polished stock, part of which was left full size and the balance turned to various sizes concentric with the full diameter of the bar. We adapted a speed lathe to do the job.

The center drills were made of tool steel, as at *A*. *B* was a socket, into which the drills *A* were fitted; it was used in the tailstock. *C* is a standard for setting the jaws of the steady rest. The sizes on it vary by sixteenths of an inch but are furnished 0.005 under size so that the jaws of the steady rest will be tight on the stock and prevent it from jumping. *D* is a tapered driver. It was turned inside with a coarse feed so as to give a sort of screw-thread effect. The jaws of the steady rest are set to the standard; a piece of stock is then put in it and forced back into the driver *D* in the live spindle. The tapered thread-like surface grips the stock and rotates it while the center drill



CENTERING POLISHED ROUND STOCK

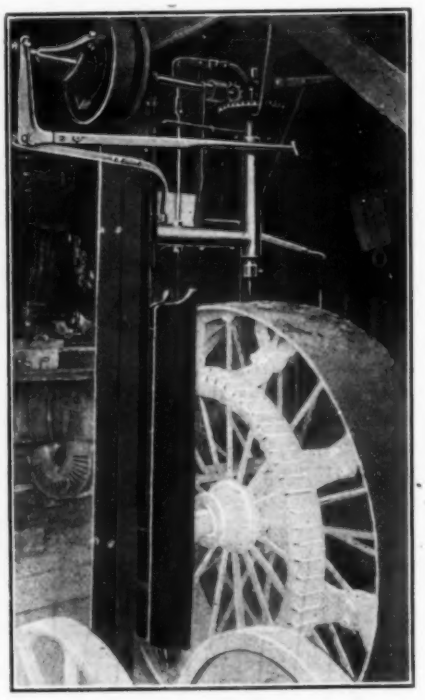
is brought in contact. A rap with a mallet releases the stock from the driver *D* and a new piece is inserted. A small hole is drilled at the bottom of the countersink, and of course this is a second operation; but even with two operations it is remarkable how many shafts a smart boy can center in a day.

England. E. BRUM.

[A combined drill and countersink would obviate the necessity of a second operation.—ED.]

Making a Drill Press from a Binder Axle

We don't know what we can do till we tackle a hard job with no tools to do it with.



A DRILL PRESS MADE FROM A BINDER AXLE

After I undertook to drill 336 holes in four road-engine drive wheels, one pair 14 inches and the other 16 inches face by 60 inches in diameter, and nothing but a small drill in the shop, I wished I wasn't there; but after I looked the scrap pile over I decided to make a drill.

A McCormick binder head was bolted to two long, square timbers, as shown, and I made the drill head after a little bracing and anchoring. My feed lever was swung over the upper end of the drill spindle to raise and lower the drill. I then put on another lever, shown just above the engine driver, to connect a rod close to where this lever hinges, and at the outer end of the top lever, to give me power feed. For a drill rest I used a sawmill screw-head block and swung the 60-inch wheels on the knee; for this light drilling I could run the knee up as close as I needed it. The accompanying illustration shows the drill and the work where we finished the last of the four wheels.

Then the boys that laughed at my McCormick drill said I had a soft snap after all. JAS. C. CRITHFIELD.

Repairing Micrometers

Mr. Norton, according to his article on page 240 of the AMERICAN MACHINIST, appears to go to an enormous amount of trouble to true up his micrometer contact faces.

A toolmaker of my acquaintance recently purchased a second-hand micrometer which was badly worn on the contact faces, and he trued these up as good as new in about one hour. This is the way he set about it. First, he put the finest grade of emery wheel he could find on the grinding-machine arbor. This was about 3/16 inch thick. Then, taking the diamond, he carefully trued it up and relieved the sides enough to cause all the cutting to take place on the rim. See the illustration, Fig. 1, which is exaggerated to show the idea. Next he opened the micrometer a little more than 3/16 inch and locked it with the locking device. He then clamped the micrometer to the grinder table and with a feeler carefully lined it up to run parallel with the wheel face. After setting it as accurately as possible in this manner, he set the micrometer stem so that the part *A*, close to the shoulder, was opposite to the wheel. He then carefully fed it forward until the wheel just drew a few sparks from the stem. The table was next fed longitudinally and a very slight adjustment soon had the micrometer so that on a fresh part the emery wheel would just draw a few sparks the whole length of the stem.

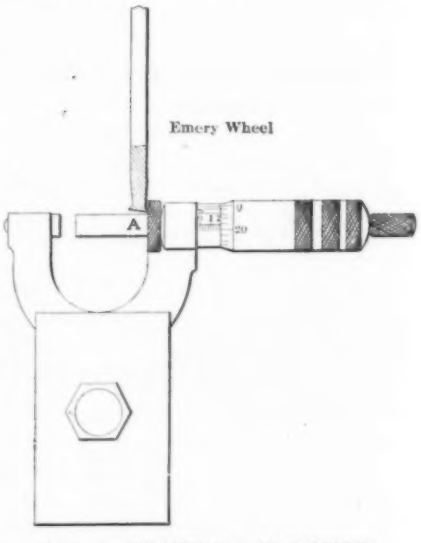


FIG. 1. REPAIRING A MICROMETER

This was repeated with the wheel on top and then it was known that the micrometer was lined up accurately to within 0.0001 inch; for an emery wheel will show sparks when cutting 0.0001 inch.

The next process was the actual grinding, which merely consisted in setting the table so that a light cut was taken across first one and then the other contact face.

The last cut on each was an extremely light one, and the table fed in and out until the wheel ceased to draw sparks.

I saw the micrometer and the contacts were as perfect as anyone could wish. I caught a feeler gage between the contacts as tightly as the ratchet stop would allow, and, upon twisting it, I could find no trace of unequal contact. I also failed to find any marks on the stem due to this method of setting.

I have not written this to throw discredit upon Mr. Norton's method, which is a very ingenious and accurate one, but merely to show that extreme accuracy can often be gotten by ordinary means. This method also has the advantage that, should the anvil mounting be out a few ten-thousandths which by Mr. Norton's method would throw out the anvil, it would make no difference at all, as the

FIG. 2

FIG. 3

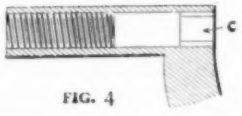


FIG. 4

ANOTHER REPAIR OF A MICROMETER

anvil is ground in position. Of course after grinding it is necessary to reset the thimble.

GEO. P. PEARCE.

Mr. Uber, on page 206, tells us how he repaired some micrometers by rechasing the thread to correct the worn places; but he did not tell how he made the nut fit after the screw had been reduced in size. It would appear that if the thread was worn, the spindle below the thread must also be worn loose so as to shake in places; and, if the micrometers had no locking device, they would certainly give a fellow's nervous system a shock to use them. I do not think Mr. Uber would have fixed them and made them less fit for use, only I would like to know how he took up the slack in the nut.

I once bought a two-inch micrometer very cheap. It was badly worn and was loose in the center of the thread and on the straight part of the spindle, as shown by Fig. 2. To repair it, I caught the thimble in a drill chuck and polished the spindle with emery cloth until it was straight for its entire length, using a micrometer to test with. I then split the nut in four places with a fine saw, as shown in Fig. 3, springing the four parts together until they gave a proper tension to hold the spindle safely when it was set.

The nut, being flexible, followed the worn part of the screw, to which I did nothing. The micrometer frame was provided with a small bushing *C*, Fig. 4. This I split and sprung together to fit the spindle by putting a piece of paper around it. Then, to hold the bushing securely in place, I drove a small wedge into the split. The micrometer worked nicely when all was done and was a finished job.

H. L. CAMERON.

Annealing High-speed Steel

Mr. Viall says that the only method he knows of for the annealing of high-speed steel is the one that he has mentioned. He also claims that the *secret* of annealing high-speed steel is to get it to a *high heat* (white, not burning). He claimed that I had advocated heating high-speed steel five hours at 800 degrees Fahrenheit, then continuing the heat at 900 degrees Fahrenheit for seven hours, making a total of 12 hours for the heating. Then he said I closed the furnace door and let cool. In the same article he said that the *secret* of annealing high-speed steel *is to keep the air from coming in contact with the work.* As to his statement that I fell into the bucket of water, I will leave that without comment. If he knows no other way of annealing high-speed steel than the method he uses, I will explain five different ways that it may be done.

First, the steel may be packed, using the same care as is used in packing carbon steel. Charcoal, ashes, cast-iron shavings from the planer or lathe may be used to pack in. Place the large pieces to the outside of the box and the smaller work to the center (as much as 100 pounds may be packed in one box), then place box and contents in a furnace suitable for this amount of work. Heat for five hours at 800 degrees Centigrade (dull cherry red), then raise to 900 degrees Centigrade (cherry red) not 800 or 900 degrees Fahrenheit, as Mr. Viall claimed, but Centigrade. As soon as the furnace reaches cherry red, shut off the fire, close the door and let cool.

I often use any one of the following methods for annealing stray pieces or rush jobs.

Heat anneal of high-speed steel can be accomplished by the following method: Take the piece to be annealed, place in the furnace, heat to 700 degrees Centigrade (somber red). Hold the piece at this heat for five hours, then let cool in the open air. It will be found that it can be worked very readily.

To anneal without packing the work, heat the piece to 700 degrees Centigrade, hold at this point for five hours, then raise the heat to 800 degrees Centigrade (dull cherry red.) As soon as the piece reaches dull cherry red, take the piece from the fire and put in lime to cool; to prevent the piece from being injured by the heating, do not raise the heat to more than 700 degrees Centigrade until just before removing.

Reheat anneal of high-speed steel can be done in much less time, and I have not noted any bad results from this treatment of high-speed steel; but I do not recommend it except in rush jobs. This is accomplished by taking the piece or tool, heating to 700 degrees Centigrade (somber red), then letting cool in the open air. Next reheat to 700 degrees Centigrade (somber red) and hold at this point for 40 minutes; then take the work from the fire and let cool in the open air. The work will not be as soft as the pack anneal or the piece placed in the lime, but it can be worked very easily and in many cases will save a great deal of time.

Annealing in a lead bath is very convenient where a stray piece is to be annealed. If the lead is of sufficient bulk to hold the heat for several hours, then it will only be necessary to place the work in the lead, raise the heat to 800 degrees Centigrade (dull cherry red) and shut off the fire, leaving the work in the lead over night, removing when the lead is reheated to the point where the work will not be coated with lead when taken from the bath. By dipping in oil and then re-dipping in the lead, the work can be taken from the lead moderately clean. Allow to cool in the open air.

I claim that steel packed as Mr. Viall recommends *cannot* be heated to a high heat (white, or 1300 degrees Centigrade) in 10 to 20 minutes. Furthermore, if it is brought to that point, it will not be soft. As to the *secret* of preventing the air from coming in contact with the work while it is hot, I will say that it does not require any more care than carbon steel after it has received the time heat. Then I wish to inform Mr. Viall that high-speed steel does not anneal below 977 degrees Fahrenheit (red visible in daylight).

Mr. Viall has contended that it was not necessary to have an elaborate apparatus for the annealing of high-speed steel. Now I do not consider that it is necessary, but I do think that by its use only can we impart intelligent information while we are considering heats.

C. U. SCOTT.

Wireless telegraph communication seems to be on a real boom. With the announcement that we are soon to have wireless across the Atlantic come reports that the war and navy departments will coöperate in establishing wireless communication between Nome and St. Michael and Seattle and San Francisco. The signal corps of the army, which has already wireless stations in the Alaskan cities and many of the coast posts will establish a station at Fort Gibbon next year, which will be in touch with a station to be erected by the navy at Valdez.

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Micrometer Dials for Planer Feed Screws

Machinists have frequently asked the question, "Why are planers not regularly equipped with micrometer dials on the feed screws?" We can answer frankly that we do not know positively, although we have one or two ideas bearing upon the matter. While it is customary with the majority of planer builders to fit graduated collars to their vertical feed screws, the cross feed, as a rule, is still unprovided with this convenient appliance for facilitating the lateral operation of the head.

It is possible that this may be partially due to the fact that a great deal of work for which micrometer adjustment of the tools would be especially handy is of such character and proportions as to be more conveniently handled on the shaper anyway, and the latter machine being usually fitted with the graduated dials or collar referred to, these may have been looked upon as superfluous when considered in connection with the cross-feed screws of planers. It may be, on the other hand, that these dials have generally been omitted owing to the somewhat limited amount of space between the ends of the feed screw and the rod that operates the up and down feed, this restricted space making it difficult, ordinarily, to admit a disk sufficiently large in diameter to give the peripheral surface desirable for graduations reading directly to thousandths, for a screw whose pitch is as coarse as is usually the case with the cross-feed screw of the planer.

That there is a real demand for such dials and that they can actually be applied when necessary is evidenced by the fact that so many planer hands have themselves put these handy devices on their machines. Only a short time ago the writer while visiting a well known tool shop was shown by the superintendent a new planer recently received at the works, and the first detail the visitor's attention was called to was a graduated dial for the cross feed, which the purchasers of the planer had applied immediately upon the installation of the machine. The remark was made by the superintendent who had had the dial put on, that they couldn't get along without this convenient feature nowadays as they had become so accustomed to using graduated dials on most of their tools. Here was an instance where it would have seemed preferable for the maker to apply the dial himself before the machine left his shop.

When one stops to consider the matter, there will come to mind a large number of planer jobs handled from day to day where graduated dials for the cross-feed screws would be a great help to the operator. In cutting down a series of grooves at a given distance apart, or in forming two or more shoulders where a certain dimension is wanted from shoulder to shoulder and in undercutting, as in a T-slot, or cutting a groove in the edge of a piece of work with a bent square point, a micrometer feed attachment is of great assistance. It is of still greater service when racks are to be cut on the planer, as it enables the operator readily to adjust the tool to the exact point required for cutting down each successive space in the rack.

The advantages of graduated dials for millers and lathe cross-feed screws were recognized long before they came to be regularly applied to these tools by their makers, and toolmakers not infrequently made such dials and attached them to the machines which they operated. Eventually they came to be included regularly in the design of the machines and are as common to day as they were infrequent in former times. It is probable that one of these days the ordinary sizes, at least, of planers will be as universally fitted with micrometer dials as are most of the other types of machine tools at present.

Has the Development of Automatic Machine Tools Gone Too Far?

A striking paper under the somewhat ambiguous title "Modern Machinery and Its Future Development" was read before the recent meeting of the British Association for the Advancement of Science, by H. I. Brackenbury, in which the author contends that the development of automatic machine tools has gone too far, at least for British conditions, and that the future development will be on the line of simple, powerful, plain, non-automatic machines for roughing out work in combination with the grinding machine for finishing and the thread-milling machine for cutting screws.

The author classifies modern machine tools into automatic, semi-automatic and non-automatic cutting machines and grinding machines for finishing the work; he points out that the aim of machine users has been to push work from the non-automatic to the semi-automatic and from the semi-automatic to the completely automatic class, the result being that the automatic and semi-automatic machines have been brought to great perfection. This he considers to have been carried too far, even under old conditions, and contends further that the value of automatic and semi-automatic machines as determined under old conditions has been completely upset by the general adoption of high-speed steel, which, he claims, brings the old, simple type of engine lathe once more to the front. He points out that until recently the cost of the time required for rough drilling, turning, etc., was a very large portion of the

total, making it desirable to do much of this work with automatic machinery, in order to reduce the wages cost. He considers, however, that the introduction of high-speed steel has so reduced the cost of roughing out as to change the situation completely. It is right here that his conclusions are most vulnerable, as many will dispute the great saving which he attributes to high-speed steel, which he considers to have reduced the cost of roughing out to as little as one-third of its former cost. Because of this he believes that "future developments will not be in the direction of larger and more complicated turret or automatic lathes, but in the direction of simple machines which can be attended to by operators of average intellect and who have not had much previous experience of machinery." He continues that the figures which are often shown to prove the value of large automatic and expensive and complicated turret lathes are deceptive, because they are based upon carefully worked out methods of doing the work in the case of the automatic machines, which are compared with methods used with old machines in which little, if any, attention has been given to the study of economy. He mentions a case of this kind in which a piece of work which had required 4½ hours on an engine lathe had been reduced to 1 hour upon a turret lathe, but which, after new special tools had been made and the method of procedure carefully thought out, was reduced on the plain lathe to 1 hour and 10 minutes.

He has put his conclusions into the form of formulas and diagrams which he claims show a very clear tendency of the work to become more expensive as the size of the automatic machines increases, and he refers to cases within his own knowledge in which manufacturers have adopted automatic machinery extensively in order to reduce labor cost, only to find that other shops with a few cheap machines turn out their work quite as cheaply and with a much smaller capital expenditure to embarrass them in dull seasons; he concludes that "The large automatic machine is a creation of the past and that the future will bring no further development in this direction." He considers that simple automatic machines of small size are of the greatest value, but that complicated machines for work requiring many short operations are not economical.

He correctly attributes the growth of automatic machinery to the bicycle industry, in which thousands of small parts were required of an exact similarity. He considers the development of these machines to be due to American mechanics, and that it grew out of the high price of labor here, which increased the necessity for their use. His formulas and diagrams show a constantly reduced economy as the sizes of automatic machines are increased, the gain becoming eventually a loss.

He considers that for roughing purposes the most economical machines are heavy, simple and cheap turret lathes, for boring and chuck work, and heavy, simple and cheap engine lathes for rough turning, and states that "curiously enough, those machines which seem the most simple and easy of perfection give the most room for development," the reason for this being that the great value of roughing out work in cheap machines with cheap labor has not been sufficiently grasped; he points out that in designing these machines "one must keep in mind that the aim is not a perfect machine, but a machine of simple construction, simple to work and cheap to buy and of considerable power." These machines are to be used for roughing only, the finishing being done on grinding machines, the use of which he considers will in the future be much more extensive than at present, although he believes that machines of a cheaper nature than those now made will be introduced to finish much of the work which is at present finished in the lathe. Screw cutting he considers will be done on screw-milling machines, which he considers to have a great future.

In concluding his paper, the author disclaims the advocacy of a retrograde policy, saying that he does not wish to bring back the old methods of using simple machines, his argument being based upon the belief that the care in scheming methods of work which have been devoted to automatic machines would, if applied to simpler machines, produce better results.

A Neglected Opportunity

It is always a good plan to find in what direction the best opportunities lie, whether as to starting a business or learning a trade; and there is one branch of the machine business which has been sadly neglected by boys and young men who wish to learn a mechanical trade.

After the patterns are made and before the machinist can have any castings to work with, the molder must put the patterns in the sand, ram it so as to put the required pressure on the different parts in such a way that they will resist the rush and pressure of the molten iron, put in just enough vents to allow the escape of gas, make gates and headers of the right size to allow the metal to flow as it should, part the molds in the right place, set and anchor the cores, and do the many things that must be right, or the casting will be spoiled. Then he must know how the iron or brass is to be mixed for the best results, at what temperature to pour it, and the many other points which make successful casting an art rather than a trade, if such a distinction is allowable. And yet most large foundries have difficulty in securing enough apprentices from among the class who have intelligence enough to make first-class molders.

The usual explanation is that the molder's trade is too dirty, that it is too hot at pouring time and that it is too hard work anyhow. But will any sturdy boy admit that these are good reasons for not taking up a trade which offers perhaps more opportunities than any other? The dirt washes off much more easily than that which the millionaire automobilist gets on his hands when the motor gets a stoppage in its internal regions, and there isn't one of us who wouldn't be proud of a black spot of grease if it fell on our nose when we were lying on our back in a dusty road underneath a nice motor car. So you see we don't object to the dirt so much as to the way we get it.

Many molders are waking up to the possibilities of their trade, and in their foundries the percentage of good castings is going up. We have a foundry in mind which, with only ordinary facilities, has not lost a locomotive cylinder in several months, and there is trouble brewing for the first man who does lose one. The foreman is an enthusiast about his work, has studied the making of cylinders from all sides and believes he has found the causes for failures, for there is always a cause even if we cannot remedy it in all cases. He has trained his men to see the reasons for things and infused them with a love for their work and a pride in having it come out right that helps everybody concerned.

There are hundreds of good jobs waiting for men of this kind. A little dirt, from a mixture of sand, loam and good honest sweat, ought not to keep any boy from learning a trade so full of possibilities if he has any leaning in this direction. Bathing facilities are provided in all good foundries; the hours are shorter than in the machine shop, as a rule. Even if a molder does not look like a bank clerk while at work, there is no law against his cleaning up so as to look his best girl square in the eye if he meets her on the way home—accidentally, of course.

If a boy is undecided as to what trade to pursue, and has grit enough to stick to it in spite of dirt and a fair share of hard work, and will study its ins and outs half as hard as he does the new baseball rules, the molder's trade is well worth careful consideration.

Monthly Meetings of the Mechanical Engineers

The monthly meetings of the American Society of Mechanical Engineers will be resumed in the main auditorium of the Engineering Societies Building, 29 West Thirtyninth street, New York October 8. The subject of the meeting will be Industrial Education and it will be discussed by leaders in the industrial-education movement.

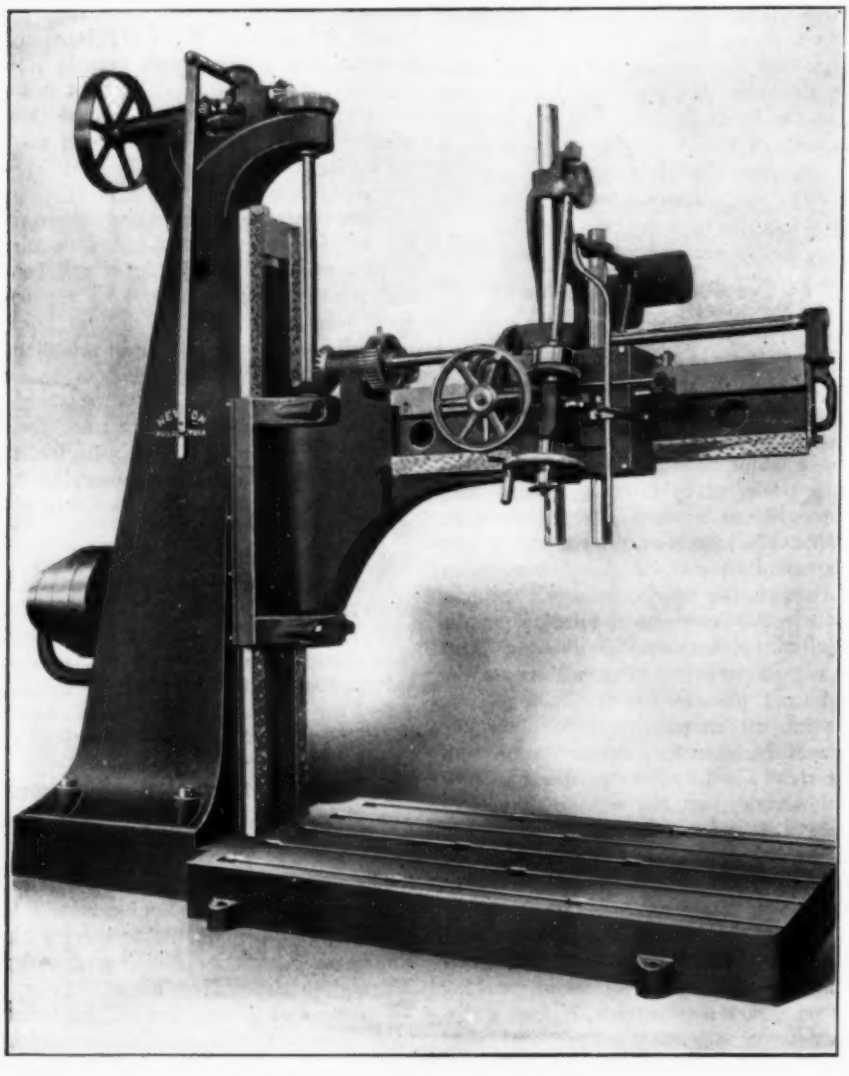
New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Radial Drilling and Tapping Machine

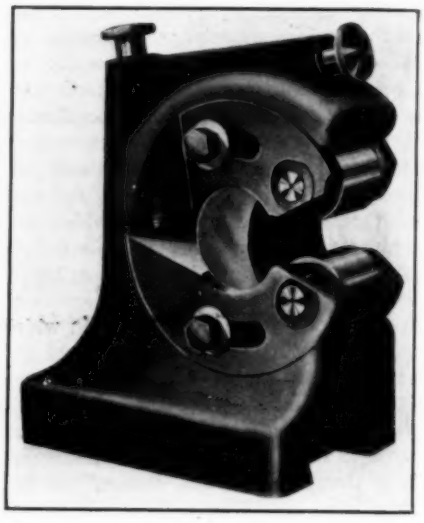
By the use of the heavy radial drilling and tapping machine here illustrated, a hole can be drilled and then tapped without any change of belt or motor speed, or throwing in of back gears, since the drill and taps are carried in adjacent spindles, geared together so that the speed ratio is 2¼ to 1; hence each runs at its own most suitable speed. There is a pointer on the hand wheel; after drilling a hole, one turn is given to the wheel, bringing the tapping spindle in line with the drilled hole; the tapping head is drawn down by means of the lever, and the clutch lever dropped into place; the hole may now be tapped. After a tap has gone through or bottomed, a quick return is obtained by reversing the lever. Both spindles have 17 inches travel, the drill spindle having an automatic feed through gearing, with four changes, and a hand adjustment. The drive of the spindle is by a four-step cone, back gears located on the radial arm, and helical gears. The tapping spindle moves freely in its quill and is evenly counterbalanced. The radial arm is fitted with roller thrust bearings, and the lower cap is arranged to clamp so that the arm can be held rigidly in position. The machine, having a 6-foot arm, is of about 12,000 pounds net weight. It is made by the Newton Machine Tool Works, Inc., Philadelphia.



RADIAL DRILLING AND TAPPING MACHINE

Roller Follow Rest

The tendency of a bar, carried on centers, to spring from the tool under the cuts that high-speed steel has made possible, makes the follow rest an attachment



SPECIAL ROLLER FOLLOW REST

of great importance in any shop where such work is done. The cut shows a follow rest entirely new in principle and designed to do away with the ill effects of high speed and coarse feed upon the solid jaws of the familiar type of follower rest, the wearing away of the jaws and the loss of power in friction.

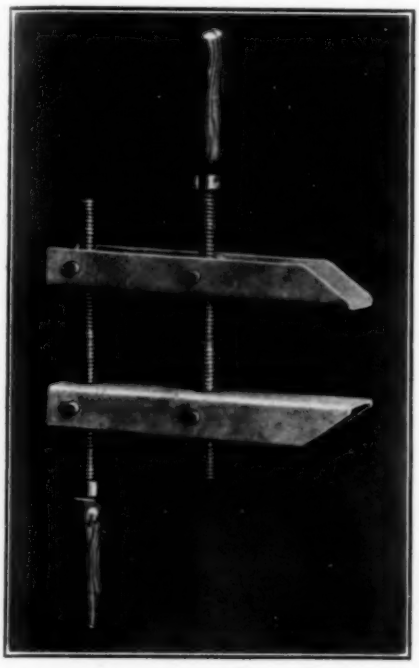
It is mounted upon the bridge of the carriage. The two jaws moved by a worm and knob, and carrying hardened steel rollers, move in and out on a circular path and give, with the cutting tool, three points of contact.

With the rollers once set, the rest is adapted for a variety of diameters by simply moving the entire rest backward or forward on the bridge dovetail. This is accomplished by connecting the rest to a screw which telescopes through the regular cross-feed screw and is operated by the hand wheel controlling the tool rest. The position of the rollers is such that, when approaching a shoulder, they support a shaft upon the smaller diameter until the cutting tool has turned a portion of the larger diameter when the rollers may be quickly brought to bear. The rollers are of hardened tool steel and have ample provision for oiling. Sensitive adjustment is made without the aid of

a wrench. The jaws once set can be locked in position. The device is made by the Lodge & Shipley Machine Tool Company, Cincinnati, O.

A Clamp

The illustration shows a clamp for the use of patternmakers, etc. The jaws, screws, nuts, etc., are of steel. As shown by the illustration, the jaws are channel shaped. The nuts have trunnions which pivot in the sides of the channel. It is claimed that these clamps are lighter than those made of wood and that glue will not adhere to either the jaws or the screws. Owing to the fact that the nuts swivel, the jaws can be adjusted to any angle to grip tapered work. The right- and left-hand threads on the screws allow it to open and close quickly. This clamp is made in five sizes, from 8 to 17½ inches length of jaws, by the Erie Stamping and Manufacturing Company, Erie, Pennsylvania.



A CLAMP

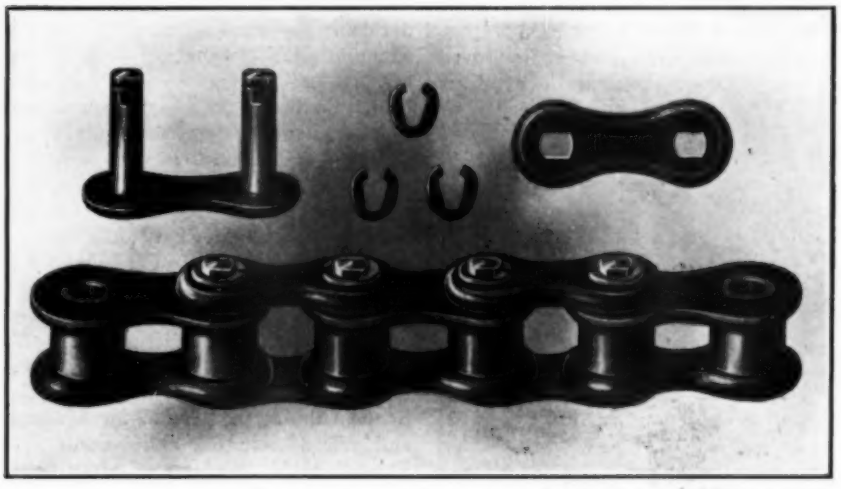
Transmission Head for Flexible Shaft

In connection with the Coates flexible shaft there has been brought out a transmission head which enables the flexible shaft to be used to transmit power from a driller, lathe or other machine tool, in order to do drilling, tapping, grinding, buffing, etc. The head consists of a clamp that is attached firmly to the flexible shaft cover, and is dogged by a rod against the column of a driller, or bed of a lathe, and keeps the cover from rotating. The end connection of the head may be gripped in any chuck. Fig. 1 shows a breast drill being driven by a lathe by means of this device, and Fig. 2 shows the multiplying device which is furnished for use in grinding and increases the speed 8 to 1. This device is made by the Coates Clipper Manufacturing Company, Worcester, Mass.

A New Detachable Chain

The novel feature of this chain is that while it is composed of the usual pins, rolls and side links, each side link on one side is readily detachable, so that any new parts may be substituted at any portion of the chain.

This is accomplished by making one end of the pins as shown in the separate link, with grooves to hold the small clips,



A NEW DETACHABLE CHAIN

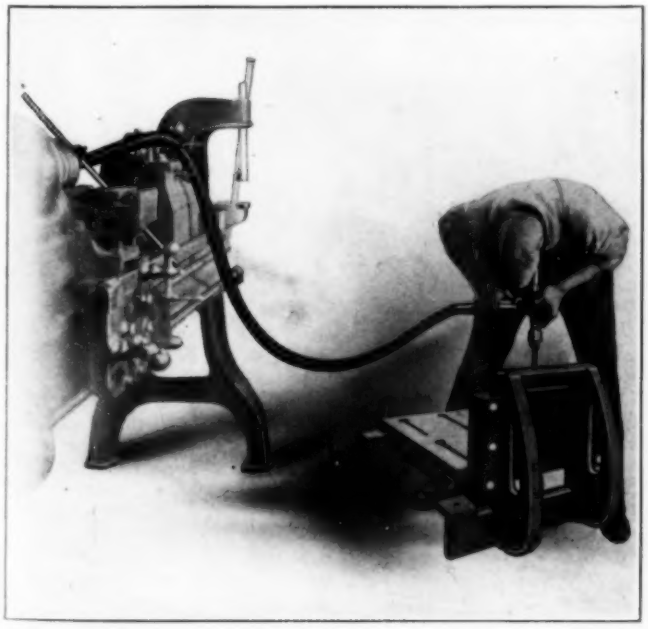


FIG. 1. BREAST DRILL DRIVEN FROM LATHE

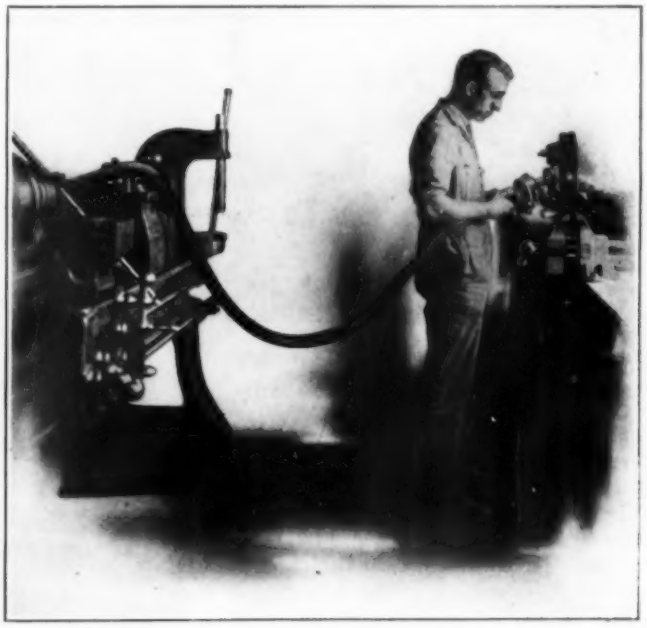


FIG. 2. FLEXIBLE SHAFT WITH TRANSMISSIO N HEAD AND SPEED MULTIPLIER

shown separately. The pins are slipped through the bushings of the roller links, the side links put over the ends of the pins and the clips sprung into place in the grooves.

These hold the side links firmly in place, but are easily removed with an ordinary screw-driver or anything else that will pry the open end apart enough to slip it off the pin. After replacing the side link, the clip can be sprung back into the groove. It makes a very secure fastening, owing to the groove being flat so as to prevent any rocking or turning of the clip. It is made by the Baldwin Chain and Manufacturing Company, Worcester, Massachusetts.

Improved Tool Post

The two half-tones show an improved tool post, the construction of which is

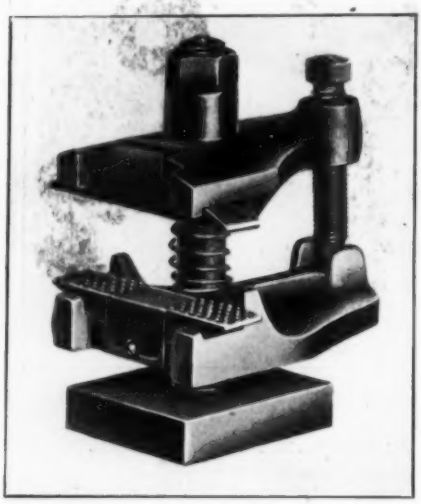


FIG. 1. ARMSTRONG IMPROVED TOOL POST

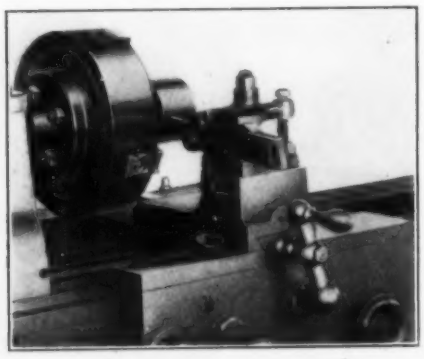


FIG. 2. ARMSTRONG IMPROVED TOOL POST IN SERVICE

quite apparent. The body parts are steel drop forgings. It is designed with a view to strength, stiffness and holding power. The rocker jaws adjust themselves to the tool or tool holder, and the latter is not marred; the open side facilitates changing tools. As is evident in Fig. 2, it may be used in working close up to the chuck. By the use of a pair of V-blocks between the jaws, round tools, such as boring bars, may be held. This tool post is made in four sizes by Armstrong Brothers Tool Company, Chicago, Illinois.

Deep Drilling Attachment for Lathes

We illustrate the adaptation of an engine lathe for rapid deep drilling by means of an attachment carried upon the lathe carriage. The drill-spindle bearing, with the bracket upon which the motor is mounted, is cast as one piece with the bed plate. This plate is bolted to the wings or arms of the carriage.

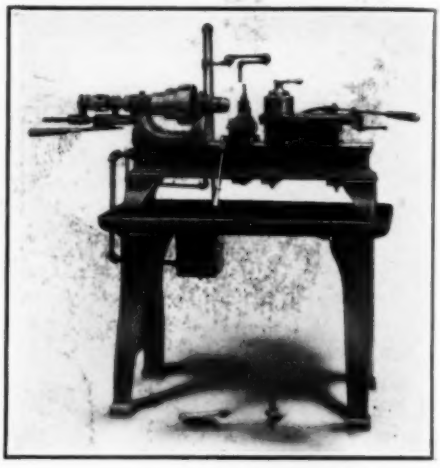
A three horse-power 2 to 1 variable-speed motor is shown. The motor pinion drives through an intermediate rawhide gear into the large driving gear keyed to the drill spindle. The spindle is bored to admit lubricant to the drill, has a large bearing and is ring oiled. The bushed drill shank fits into the hole in the spindle. The outer end of the drill is carried in a free bush that revolves in a support bolted to the lathe bed.

The drill used is of special construction and is known as the Chard deep drill. A flat bit of high-speed steel is held in position by a taper pin and is ground so as to break up the chips and so facilitate their removal. Lubricant under pressure sufficient to clear the chips and cool the cutting edge is supplied by a pump attached to the lathe at the rear of the headstock and driven from the lathe countershaft. Flexible tubing connects with the hollow spindle through a nipple at the rear, and two copper tubes flush with the surface of the drill carry the lubricant to the drill point. This type of drill has been in use for some time on lathe spindles, back-gear sleeves and pulley sleeves. Under most favorable conditions a 2-inch drill has been advanced at the rate of 2¼ inches per minute. The drill in the cut is 1 inch in diameter and is used on holes 44 inches deep in locomotive driving axles.

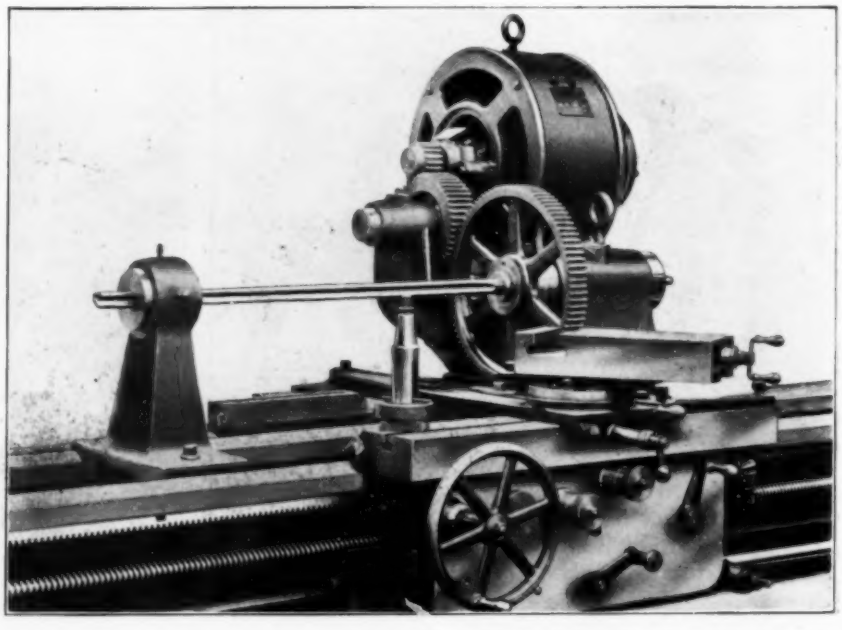
The whole attachment may be easily removed from the carriage by means of an overhead crane, a few minutes' time being all that is required to change over to engine-lathe work. It is made by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio.

A Screw Machine

The illustration shows a screw machine which takes 5/8-inch diameter rod through the wire feed. The machine is built with either a 4- or 6-hole automatic turret, and if desired, a 4-hole hand turret can be furnished instead. The wire-feed mechanism has inside the spindle an extra tube and collet which feeds the bar until it is all used up. This inside tube and collet can be taken out and the machine used with the automatic chuck with hand



A SCREW MACHINE



DEEP DRILLING ATTACHMENT FOR LATHES

feed; in this way it has a capacity through the chuck of 7/8 inch.

This machine is built by F. E. Wells & Son Company, Greenfield, Massachusetts.

A 20-inch Engine Lathe

Fig. 1 shows the general appearance of a 20-inch lathe of new design. The headstock has a three-step cone with which, in conjunction with double back gears, nine changes of speed are obtainable. The quick-change gear box shown in Fig. 2 gives eight changes of geared feeds and permits eight different pitches of screws to be cut by moving the ball lever shown. A small compound gear located at the head of the lathe permits eight more feeds to be obtained and eight more screw pitches to be cut. Three extra change gears are also supplied so that the feed range is from 4 to 240 per inch and screws from 2 to 60 per inch can be cut.

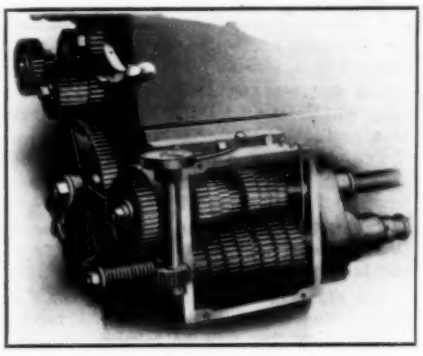


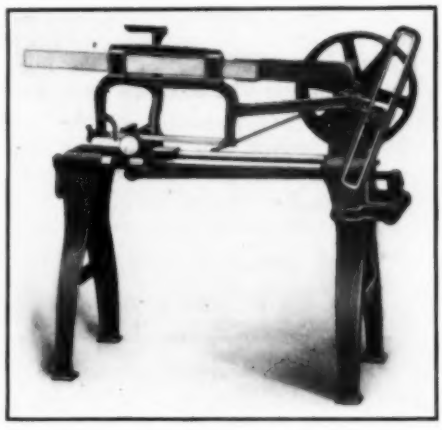
FIG. 2. THE GEAR BOX

The gear box carries two shafts. To the upper one are keyed eight gears which mesh with loose gears mounted on the lower shaft. The lower shaft carries two spring-actuated keys so placed as to engage the loose gears in progression according to size. The lower shaft is in line with the feed rod and may be connected with it by the jaw clutch shown, or with the lead screw by means of gears, one of which is mounted on the lead screw and is slid into or out of engagement with that upon the lower shaft.

The operating friction on the carriage is adjustable, for light or heavy work, from the outside by turning a small nut. A friction countershaft, large and small face plates and the necessary wrenches are furnished with this lathe, which is built by the Whitcomb-Blaisdell Machine Tool Company, 134 Gold street, Worcester, Massachusetts.

A Power Hack Saw

The illustration shows a power hack saw. The saw frame slides on a rectangular guide-bar, working in babbitted bearings. A split finger is provided to hold the saw blade in alinement. The saw frame has quick returns by means of a slotted lever drive. It can be thrown back to leave the vise clear.



A POWER HACK SAW

The vise is provided with a right- and left-hand screw. When the cut is finished, the machine trips the friction clutch and stops automatically.

This machine is built in three sizes, viz., for stock 4, 5, and 8 inches square or round, by E. C. Atkins & Co., Incorporated, Indianapolis, Indiana.

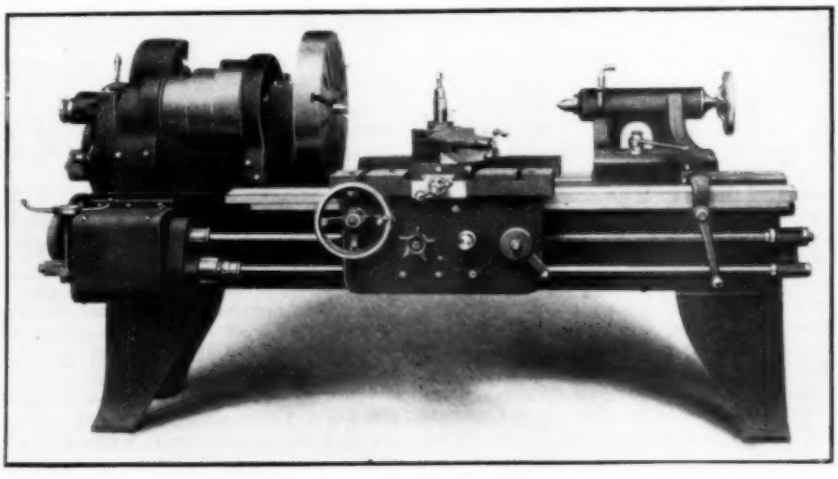


FIG. 1. 20-INCH ENGINE LATHE

Filing Clippings without Indexing

By James Hutcheson

Regarding the several articles that have appeared lately on the filing of extracts, cuttings, etc., from the trade papers, I fail to notice one method that I can recommend.

Most of the previous systems have struck me as being cumbrous, unwieldy attempts at keeping a record of elevating and interesting things incidental to one's profession. The method I will describe has the advantage that the basic idea has been thought out and developed by commercial men, men whose profession it is to file records of the every-day happenings of their offices, as they apply to their separate customers. The records can be found at once and without the necessity of turning up indexes. It has also found its way into a few engineering shops, for specifications of machines where different sizes and styles are made, as it readily permits of extensions and alterations. It is cheaper than most systems to install, the up-keep is usually less and it can be extended indefinitely, which cannot be said of some of the previous systems. The files take up practically no more room than is necessary for the actual cuttings, too, which is one good point in its favor, as an engineer can keep the files in his box at his lodgings, where room is sometimes at a premium.

The "separate" or "flat" filing system can best be described in a few words as follows: A separate file for each kind of matter, distinction being made easy by means of different colors; for instance, blue may be used for grinding, orange for turning, pink for erecting, buff for milling, etc.; in fact, this system offers great adaptability in this respect, each user being able to work out his own scheme. This being settled, the files are indorsed on the back according to contents; the particular file you want can be found at once.

The file consists of a piece of tough, tinted manila paper, folded, on the inside of which is securely fastened a flexible metal clip with two points on which the papers are placed, after being punched with a punch supplied for the purpose; the points are bent outward and the filing is complete. The files, which take up only the room of the papers themselves, have expanding backs which open out with the growth of the contents, the capacity of each file being about 300 papers. The files cost twopence or threepence each, according to style, and the punch two shillings, sixpence. Surely no one can object to the initial cost of this system.

Gummed slips, ruled sheets and sheets with a gummed strip on them can be had ready punched for filing cuttings which are too small to be placed on the clips

themselves. No cutting is too small to be taken care of in this way, and it obviates the danger of small clippings slipping inside folded sheets and getting seemingly lost when they are wanted, as happens often with the envelop system. The files can be had in different sizes, but the size I am in the habit of using is 12x9 inches, which just takes in a full page of the AMERICAN MACHINIST without folding, and is certainly not cumbrous for its size, as it is so thin. I find this system of filing much better than binding whole volumes of the MACHINIST, as I can tear out copiously from the paper, file all the articles appertaining to the branch of engineering I am interested in and throw out the rest as so much lumber, which it certainly is to me, so why keep it?

There is no index required in this system; you simply take the cutting, punch the holes in it and place it in its proper file. Should the papers in any one file get too many to enable any special one to be readily found, the contents of that file can be subdivided and a sub-title given. This subdivision can take place in the one file by simply inserting a sheet of paper of a distinctive color and bearing the sub-title; or again the contents can be split up into several files of the same color as the original one and bearing the original title plus the sub-title; for instance, grinding may be subdivided into cylindrical grinding, flat grinding, chatter marks, grinding machines, kinks, etc.

Another point in its favor is that this system does not entail a lot of work to begin, no getting boxes made, index drawers in order or special cards printed; you simply buy your files, print on the title and away you go.

Before concluding, let me quote from "American Toolmaking," by Joseph Woodworth. This author's varied books on machine-shop practice will be themselves a good recommendation to what he says: "It will be well to present a few remarks on the advantage of keeping note-books in which to note and preserve the valuable and useful information which abounds in the mechanical press and of which one becomes informed through association with brother mechanics or through experience and practical observation. It is a fact that the diffusion of knowledge is greatly retarded by engineers in general trusting to their memory for the preservation of valuable information, instead of to more reliable means."

The most simple way to gain by one's reading and observation is to determine to fix upon some plan within one's capacity, means, and opportunities — those which come in one's daily routine—and to follow it perseveringly, regularly, and punctually, as an important factor in one's daily duties. Many men owe their success in life to the keeping of note-books in which they had noted information which, while of little moment at the time when written, proved of inestimable value at a later date. By following some plan one will become a close and accurate observer, an enlightened and well-informed man and a better mechanic; no matter what line he is engaged in, he will not only gain in knowledge, but may gain financially by publishing in the mechanical press any information which has come to him through experience and observation and which appears to be new or novel.

Personal

Mr. E. W. Buechling, of Pittsburg has been appointed to fill the new position of Assistant Manager of Sales of the Pittsburg Automatic Vise & Tool Company.

L. P. Willsea, formerly with the C. J. Palmer Company, and for the past three years with the Ingle Machine Company, has taken the management of the J. Emory Jones Estate, at Rochester, N. Y.

Obituary

Walter Scott, inventor and builder of printing and folding machinery, died at his home in Plainfield, N. J., on September 14, at the age of 63 years.

Robert A. Brown, president of the New Haven Manufacturing Company, died September 22, in his 71st year. He was connected with his company for 52 years, being at its head for the past 31 years. Besides being a well-known figure in the machinery trade, Mr. Brown had many and varied interests.

Business Items

The Cincinnati Electrical Tool Company, announces the opening of a Western office and warehouse for the sale of their electric tools at Eighteenth and Rockwell streets, Chicago, with Oscar P. Wodack as manager.

The Bristol Company Waterbury, Conn., in order to take care of the increasing demand for their recorders and steel belt lacing will build another new addition to their present plant.

The Buffalo (N. Y.) Forge Company, has recently received an order for a horizontal center crank compound engine for direct connection to a General Electric Company's generator, this unit to be used for the electric illumination of the tower of Noshire, Japan.

Trade Catalogs

The Risdon Tool Works, Inc., 63 Canal street, Waterbury, Conn. Pamphlet illustrating and describing sub-presses.

The Brown Hoisting Machinery Company, Cleveland, Ohio. Pamphlet describing ore handling locomotive cranes. Illustrated, 28 pages, 6x9 inches, paper.

Brown & Sharpe Manufacturing Company, Providence, R. I. Catalog No. 109 and price lists of machinists' tools. Illustrated, 184 pages, 6x9 inches, paper.

The J. M. Carpenter Tap and Die Company, Pawtucket, R. I. Catalog No. 17 of taps, dies, screw plates, die stocks, etc. Illustrated, 158 pages, 3½x6 inches paper.

Manufacturers

The Terrell (Texas) Foundry and Machine Company will rebuild plant destroyed by fire.

The Bettendorf Metal Wheel Company, Davenport, Iowa, will erect new factory buildings.

The Toronto Bolt and Forging Company, Swansea, Ont., will erect an additional plant to cost $30,000.

The Foote Bros. Gear and Machine Company, Chicago, Ill., will erect a new warehouse and factory.

A two-story machine shop will be erected for P. Melchoir, Omaha, Neb., at Thirteenth and Howard streets.

The Mobile (Ala.) Fish and Oyster Company will erect an ice and cold storage plant at a cost of $40,000.

The Rauch & Lang Carriage Company, Cleveland, Ohio, is erecting a new power house and machine shop.

The Colorado Ice and Storage Company, Denver, Colo., will erect a $150,000 addition and install new machinery.

The plant of the Hollow Stay Bolt Company, Cuyahoga Falls, Ohio, recently destroyed by fire, will be rebuilt.

A new factory will be erected for the Decker Electrical Manufacturing Company, Philadelphia, Penn., to cost $25,000.

The machine shops of the California Canning Company, Oakland, Cal., were destroyed by fire, causing a loss of about $20,000.

The Kinnear Manufacturing Company, Columbus, Ohio, making steel doors and shutters, is building a large molding room.

The John Lauson Manufacturing Company, New Holstein, Wis., engine builders, will erect a new machine shop and foundry.

It is reported that the Delaware Seamless Tube Company, of Auburn, Penn., intends to erect a plant at Sarnia, Ont., at a cost of about $250,000.

The Crescent City Auto Company, New Orleans, La., has been incorporated to manufacture automobiles. Capital, $30,000. President, William P. Johnson.

The Vincennes (Ind.) Press and Husker Company has been organized with $20,000 capital. The company will also do a general machine and foundry business.

The Independent Press Brick and Tile Company, Carrollton, Texas, recently incorporated, will erect and equip buildings at a cost of about $50,000. Address is Juanita building.

The Golt Manufacturing Company has been incorporated at Oklahoma City, Okla., to manufacture automatic dump wagons, cement mixers, etc. Capital $500,000. W. R. Golt, president.

The Rockford Machine and Shuttle Company, Rockford, Ill., has been incorporated by W. B. Johnson, August Miller and Peter Engstrom to manufacture shuttles and small drill presses.

The Columbiana (Ohio) Foundry and Machine Company has been formed. A plant for the manufacture of large castings and heavy iron structural work will be put up. R. H. Mills is manager.

Three buildings will be erected for the John F. Byers Machine Company, Ravenna, Ohio, manufacturing hoisting machinery. These will be a machine and blacksmith shop combined, a foundry and a pattern storage building.

The Virginia Blower and Manufacturing Company, has been incorporated at Richmond, Va., with $50,000 capital. The company will manufacture blowers, cornices, steel tanks, etc. W. Pernot Patterson is president.

The Boston & Albany Railroad Company has awarded contract for the construction of engine house, machine and blacksmith shop and office building at North Adams Junction, Mass. Walter Shepard, chief engineer, B. & A. R. R. South Station, Boston, is engineer.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free.E.G.Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Can supply gray iron castings promptly. Brownville Iron Works, Brownville, N. Y.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Automatic and special machines designed. E. A. Johnson Co., 28 Second Pl., Brooklyn, N. Y.

Special machinery and manufacturing plants. Albert Pott M. E., 23 Platt St., New York.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Orders in quantities for brass castings from ¼ to 2 lbs. in weight. Box 454, AMERICAN MACHINIST.

Machine design, assembly and detail drawings; difficult and complicated work solicited. M. W. Burwell, New Haven, Conn.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robertt J. Emory & Co., Newark, N. J.

Special machinery to order. Catalog of small engines and boilers and engine castings 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Multiple drill for drilling flanged fittings and flanges; 10-ton traveling crane, 32 ft. span; tapping machine for pipe fittings and flanges. Materne Mfg. Co., St. Louis, Mo.

Machine shops supplying "stone splitting machines" for preparing stone for making boulder pavements are requested to mail estimates under M. O. 4399 to Rudolf Mosse, Munich, Germany.

1088 Questions answered—every day machine shop stickers—all for $1.50. "Questions and Answers from the AMERICAN MACHINIST." Hill Publishing Co., 505 Pearl St., New York.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if its "right." Roy Machinery Co., Minneapolis, Minn.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Northern New York Company wants good patented machine or useful article to manufacture; machine shop, wood shop, iron and brass foundry; water power; will sell interest in plant to proper party. Box 436, AMERICAN MACHINIST.

The Mechanics' Correspondence School teaches a short course in Engineering Mathematics, such as will interest tool and die makers, machinists and first-class workers in any mechanical trade. Address inquiries to Box 455, Lockport, N. Y.

Draftsmen, engineers, learn automobile drafting and designing including the latest European and American practice; the only field not overcrowded; instruction in classroom and by correspondence. The New York School of Automobile Engineers, 146 West 56th Street.

Wanted—High-grade machine work, especially for screw machines and turret lathes. We can refer to a very well known line of high-grade tools now on the market to demonstrate that we are able to do the highest grade of interchangeable work. Box 386, AMERICAN MACHINIST.

Wanted—Grinding men looking for more pay. "Precision Grinding by Darbyshire" ($2.00 postpaid) is worth more than that every week. Hill Publishing Company, 505 Pearl St., New York.

Arrange with us to do your manufacturing; we are thoroughly equipped for all class of machine work, including screw machines and punch parts, tools, jigs, etc.; we design and build special and experimental machinery, also automobile and marine gasolene engines. Forest City Specialty Manufacturing Co., of Rockford, Ill.

For Rent at Yonkers—A 3-story factory located 300 ft. from New York Central depot and 600 ft. from Hudson River boat landing. Building in perfect condition with complete equipment of drive shafting, 40 H. P. Engine, 80 H. P. Boiler and Dynamo for complete lighting. Floor space 13,000 sq. ft., together with 2300 sq. ft. of yard room. Two large fire-proof vaults in offices. Box 393, Yonkers, N. Y.

Technically educated, practical inventor and engineer of international reputation, who has received several awards and been decorated by royalty for his productions is constantly producing new and valuable inventions and processes, embracing electrical, mechanical and chemical lines; furnished all ready for manufacturing; factory installed when desired; wishes to make additional connections with responsible manufacturers to market; references exchanged. Box 318, AMERICAN MACHINIST.

Wanted—An interest in a small or moderate sized machine shop, by a gentleman having a general knowledge of the business and who will have a small amount of machinery of rather high-grade to build; buildings must be of recent construction, detached and having considerable vacant land for future extensions; tools and equipment must be fairly modern; location on some main line of railroad preferred; must be in a good labor market; all communications must be considered confidential by both parties. Box 464, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Position as foreman automobile shop preferred; at present in charge; accustomed to interchangeable work; references given. Box 456, AMERICAN MACHINIST.

GEORGIA

Position as superintendent or general foreman on electrical apparatus; special machinery, or general machine work. Box 465, AMERICAN MACHINIST.

ILLINOIS

Practical foundry manager desires position with good reliable firm. Box 452, AM. MACH.

MASSACHUSETTS

Position as superintendent of a factory manufacturing medium or light machinery. Address Box 421, AMERICAN MACHINIST.

Practical mechanical engineer and works manager, for past ten years in charge of large machine works desires to change. Box 451, AMERICAN MACHINIST.

Wanted—Executive position by young man, aged 36; technical and practical experience as designer of automatic machinery and special fixtures and tools for same, have held position as assistant superintendent; can furnish first-class references as to ability and character; open for engagement after Nov. 1 Box 457, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Box 453, AMERICAN MACHINIST.

Wanted—A position as chief engineer, mechanical and electrical; can furnish the best of references by inquiries. Box 183, AM. M.

Draftsman, practical man, 30 years of age with experience on fine machinery desires position; technical graduate. Box 471, AMERICAN MACHINIST.

Wanted—Position as foreman in manufacturing works; successful in producing first-class work with unskilled help; A-1 references from past employers. Box 470, AM. M.

Iron molder with 20 years' of experience on jobbing, machinery, engine and structural work, core making and melting wants steady work by the day or contract; has had charge of several small shops. Box 467, AM. MACH.

A young and up to date toolmaker with many years' experience on tools, dies, experimental work and manufacturing; would prefer a position as inspector or foreman or any position of trust. Box 473, AMER. MACH.

Expert mechanical engineer on automatic machinery having perfected machine in the west desires to locate east; this is excellent chance to secure high-grade man for this kind of work. Box 469, AMER. MACHINIST.

Superintendent or foreman, general designer, tools, dies, special machines, executive ability, systematic, thorough in details and inspection, a producer, desires position in Brooklyn or New York. Box 462, AM. MACH.

Leading draftsman, with 3 years' shop experience and 11 years as draftsman and designer on steam-shovels, dredges and power plants, wants position; the best recommendations if wanted. Box 432, AMER. MACHINIST.

Position wanted as superintendent or head foreman by technical and practical man; 35 years of age; expert mechanic, designer of special machinery and tools, dies, jigs and fixtures for cheap and accurate production. Address "H. K.," AMERICAN MACHINIST.

Experienced automobile and marine motor designer, in responsible position with prominent company, wants leading connection with progressive concern; 8 years' successful work in commercial and pleasure cars, air and water cooled, 2 and 4 cycle motors, in this country and abroad; first-class executive ability, experience in handling men, competent to build up business for parties starting these lines; highest references; appointment at New York during auto. shows. Box 440, AM. M.

OHIO

Up-to-date man; experienced manufacturing light and medium interchangeable machinery and tools for same; wants responsible position; has shown good resuls as head-draftsman. Box 472, AMERICAN MACHINIST.

Chief draftsman and engineer of 12 years' successful experience desires change; experienced in mechanical and structural engineering; of inventive and executive ability; technical education; best of references; complete details with interview or correspondence. Box 418, AMERICAN MACHINIST.

PENNSYLVANIA

Works superintendent desires change; will accept position as superintendent or manager with concern up to date or desirous of being brought to that condition; technical graduate; ten years' active experience; will give satisfactory reasons for changing and best of references. Box 468, AMER. MACHINIST.

FOREIGN

Master mechanic; American, desires to locate on Pacific coast; now employed in South America; erecting, manufacturing or maintaining, varied experience; age 36; salary $200. Box 349, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA

Wanted for the West a foreman for high-grade work in the line of model, experimental work, tools, dies, general machine work, manufacturing of novelties and drawing work connected herewith; only first-class men who will give references and state experience in full will be considered. Box 455, AM. MACH.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—First-class man for superintendent with concern beginning the manufacture of a light complicated machine requiring high-grade work; energetic, experienced man required; give full particulars about self. Box 459, AMERICAN MACHINIST.

ILLINOIS

Wanted—Superintendent for factory employing seventy-five to one hundred men; must be practical mechanic with executive ability, able to reduce cost to minimum and install piece work; permanent position to right man; give age, experience, reference and salary expected. Box 460, AMER. MACH.

Wanted—Superintendent for light manufacturing plant making addressing and duplicating machines and supplies; new fireproof building having 50,000 ft. floor space; must be an expert on dies and jigs for manufacturing interchangeable parts and be fully competent to manage all kinds of help; give age, experience, references and salary expected. If desired, application will be kept confidential. Addressograph Co., Chicago, Ill.

KENTUCKY

Wanted—Business manager for machine shop, representing an investment of $100,000 in a city of 175,000 inhabitants, located in Ohio; desire man who can invest $10,000. Address, with references, "Manager," Box 442, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Operators on Gleason gear planers. Boston Gear Wks., Norfolk Downs, Mass.

Wanted—First-class foremen and inspectors for fine mechanical work of medium and large size. Write particulars to "F. S. D.," AMERICAN MACHINIST.

First-class mechanical draftsman with large experience wanted for permanent position in New England; apply stating age, education, experience and salary expected to Box 411, AMERICAN MACHINIST.

MICHIGAN

Owing to increasing business we are constantly in need of first-class machinists both for floor work and tools, also first-class molders. For further particulars address Wm. E. Hill & Co., Kalamazoo, Michigan.

NEW JERSEY

Wanted—Agents for portable gasolene rotary and centrifugal pumps successfully used in the East for nearly two years; liberal commissions. La Vergne Pump and Machine Co., Newark, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK

Wanted—First-class detail draftsman for work in New York City. Box 431, AM. MACH.

A first-class all around machinist wanted for foreman in a machine shop employing 30 to 35 men. Box 463, AMERICAN MACHINIST.

An executive manager wanted for responsible, salaried position by established, paying, manufacturing firm; able to invest $10,000 after satisfactory investigation and audit. Write George Bradley, 1 Union Square, New York.

OHIO

Wanted—Foreman in an ice machine manufactory; first-class practical man. Address Box 466, AMERICAN MACHINIST.

Wanted—A first-class die maker, one who is capable of designing and making dies for kitchen utensils. Address Spellacy-Raiff Co., Coshocton, Ohio.

Wanted—Draftsman, experienced on heavy machine tools, particularly boring mills above six feet; give experiences and salary wanted. Box 384, AMERICAN MACHINIST.

Wanted—First-class foundry superintendent for machine molding grey iron foundry of 50 tons capacity; the foundry is equipped in a strictly up-to-date manner; no hand molding; only green men employed; applicant must be strictly temperate in habits, of good character, aggressive and must possess an abundance of executive ability; full knowledge of all molding machines and best application of patterns is absolutely necessary; give full particulars and references; no cheap man need apply. Box 376, AM. M.

PENNSYLVANIA

Wanted—A draftsman, one with experience in machine tool work preferred; must be accurate in his work; state experience and salary desired. Box 443, AMERICAN MACHINIST.

Wanted—Lathe hand experienced on turning cranks and other accurate work, for operating 42-in. lathe; also several vise and floor hands. The Shepherd Engineering Co., Williamsport, Pa.

We are increasing our capacity and invite applications from all classes of strictly first-class machinists; steady work, good wages, open shop, nine-hour day; no labor troubles. Riverside Engine Company, Oil City, Pa.

On account of increased business we are constantly in need of high-grade planer, lathe and boring mill hands; also competent erectors; no labor troubles. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—First-class machine shop foreman to operate shop employing seventy-five men, building gas engines; shop located in Pennsylvania; state experience and salary expected. Box 423, AMERICAN MACHINIST.

Wanted—First-class die maker, must be familiar with drawing and forming dies; one who is capable of taking charge of die makers, good chance for right man, steady work; give reference and state wages expected. Box 424, AMERICAN MACHINIST.

Several men familiar with high-grade steam engines, for erecting and testing department of engine works, also for outside erecting and starting; to receive consideration, give duration and full details of past and present employment, compensation received, etc.; communications held confidential if desired. Box 458, AMER. MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

Nearly new bench lathe and tools. A. F. Wisner, 119 N. Norwood ave., Buffalo, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

Machine shop for sale; $3000 a year; owner died; big sacrifice for cash. Address Box 112, Georgetown, Colo.

One 2 in. Potter & Johnston semi-automatic turret lathe in A-1 condition; one 2⅝ in. Cleveland plain automatic turret lathe in A-1 condition. Box 461, AMER. MACH.

For Sale—Two No. 00, three No. 0, one No. 2 Brown & Sharpe second-hand automatic turret forming machines. Strong, Carlisle & Hammond Company, Cleveland, O.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Complete patterns for eleven, thirteen and fifteen inch speed lathes together with jigs, reamers, etc., used in manufacture of said lathes. Grimes & Harris, Leominster, Mass.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

For Sale—One 75 Horse Power, 3 Cylinder, Marinette Walrath Gas Engine complete with 125 horse power Smith producer, Air Tanks, Mufflers, Purifiers and Piping complete. Can be seen on foundation at works of Diamond Iron Works, Minneapolis, Minn.

For Sale—The following new machinery, all in A-1 condition: 1 No. 3 Becker-Brainard vertical milling machine with rotary table, etc.; 1 Sibley & Ware power drill 20-inch table; stationary head, back geared, self feed, etc.; 1 Ferracute embossing press, class E, series E 3, made by Ferracute Machine Co., of Bridgeport, N. J.; the above is offered on account of being too large and heavy for our work. Write or call and see it. Superior Seal and Stamp Co., 52 Woodward Ave., Detroit, Mich.

Steam engine for sale; 250 h.p. Greene automatic cut-off, double-crank, non-condensing, horizontal engine, size 16 ft. by 42 ft., two cylinders, with band fly-wheel 14 ft. by 31 in., speed 75 r.p.m.; built by F. C. & A. E. Rowland, New Haven, Conn.; this engine is in excellent condition, and has been in regular service in our factory for several years, being displaced by electric equipment in the enlargement of our plant; it may be seen running until Oct. 5, its use being discontinued after that date. Winchester Repeating Arms Co., New Haven, Conn.

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Cleveland Cap Screw Co., Cleveland, O.
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Betts Mach. Co., Wilmington, Del.
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Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
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Vandyck Churchill Co., New York.
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Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
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McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

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Standard Welding Co., Cleveland, Ohio.

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Electric Controller & Supply Co., Cleveland, O.

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Harrington, Son & Co., Edwin, Philadelphia, Pa.
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Niles-Bement-Pond Co., New York.
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Armstrong Bros. Tool Co., Chicago, Ill.
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Morse Twist Drill & Mach. Co., New Bedford, Mass.

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Cast Iron Brazing
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Lumen Bearing Co., Buffalo, N. Y.
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Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
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Poole Co., J. Morton, Wilmington, Del.
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Krupp (Thos. Prosser & Son), New York.
Witteman & Co., A. P., Phila., Pa.

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Clark Cast Steel Cement Co., Shelton, Conn.

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Whiton Mach. Co., D .E., New London, Conn.

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Morse Twist Drill & Mach. Co., New Bedford, Mass.
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Cullman Wheel Co., Chicago, Ill.
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Morse Chain Co., Ithaca, N. Y.
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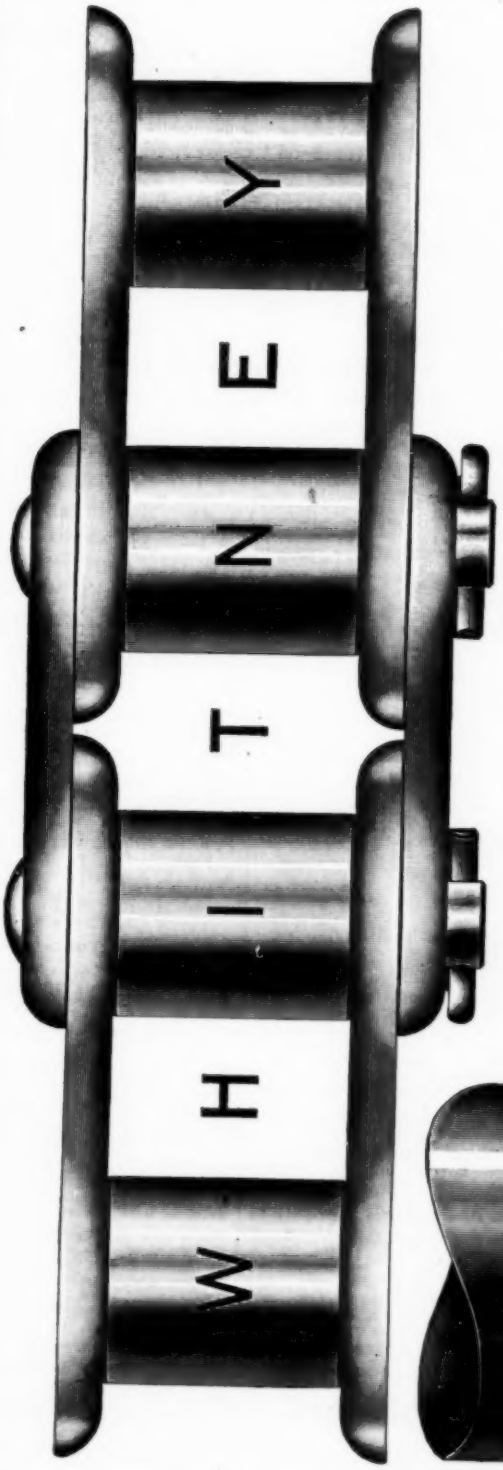
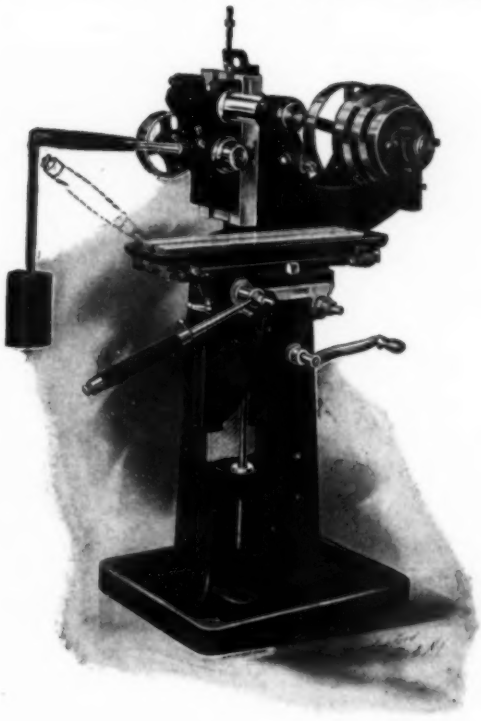
The Woodruff Patent System of Keying





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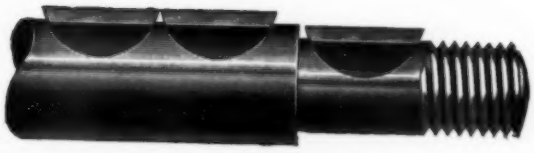

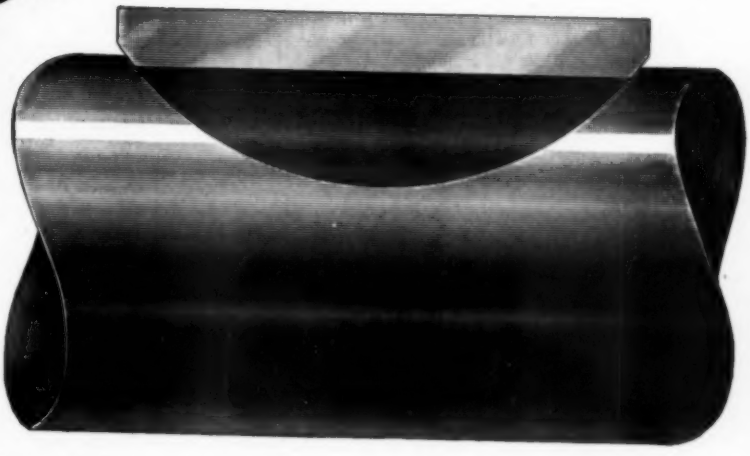

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Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

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Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

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Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

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Bartlett, E. E., Boston, Mass.
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Skinner Chuck Co., New Britain, Conn.

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Hardinge Bros., Chicago, Ill.
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New Haven Mfg. Co, New Haven, Conn.
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Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Seymour & Whitlock, Newark, N. J.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.

Countershafts—*Continued.*
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Davis Machine Co., W. P., Rochester, N. Y.
Electric Controller & Supply Co., Cleveland, O.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Crane Pullers
Walker, N. U., Boston, Mass.

Cranes
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, O.
Byram & Co., Inc., Detroit, Mich.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Krupp (Thos. Prosser & Co.), New York.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Byram & Co., Inc., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Baldwin Steel Co., New York.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Wks., Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

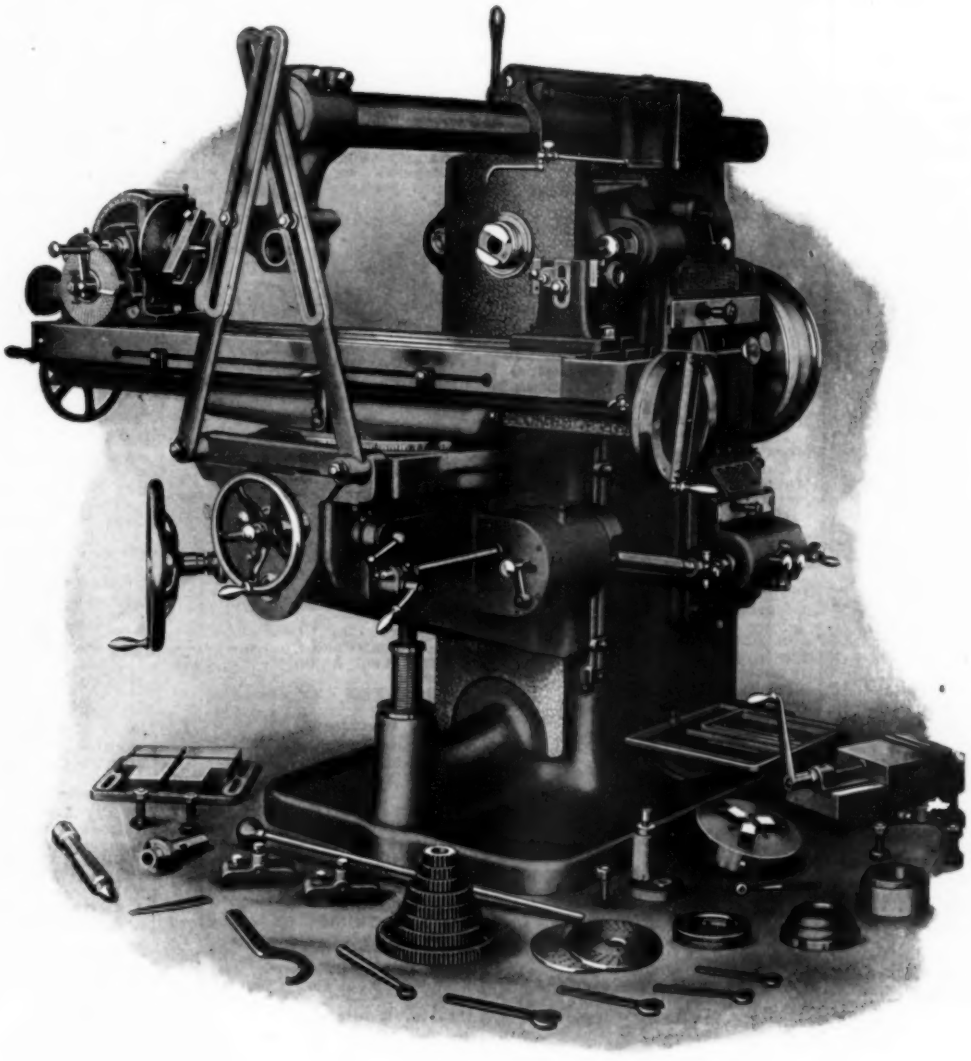
Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fairbanks Co., Springfield, O.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Globe Machine & Stamping Co., Cleveland, Ohio.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.
Risdon Tool Works, Waterbury, Conn.
Swaine Mfg. Co., Fred. J., St. Louis, Mo.
Toledo Machine & Tool Co., Toledo, Ohio.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U. S. A.



No. 4—A Heavy Universal Milling Machine

with Constant Speed Drive.

Capacity:—

Longitudinal feed, 35", Transverse Feed 12",
Vertical feed, 20", Feeds automatic.

A machine with unusual power and rigidity which is well adapted to shops where heavy milling is done.

Special circular describing the machine in detail sent to any address upon application.

Dies, Sub-Press
Risdon Tool Works, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, O.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Machine Co., The, Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle—*Continued.*
Prentiss Tool & Supply Co., New York.
Reed Co., Francis, Worcester, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, O.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Chicinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barbes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Machine Co., The, Hartford, Conn.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Reed Co., Francis, Worcester, Mass.
Robertson Mfg. Co., Buffalo, N. Y.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Upright—*Continued.*
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, Ohio.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madi-
Ridgway Dynamo & Engine Co., Ridgway, Pa.
son, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.

Electrical Supplies—*Continued.*
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Mechanical and Electrical
Crocker - Wheeler Co., Ampere, N. J.
Dodge & Day, Philadelphia, Pa.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

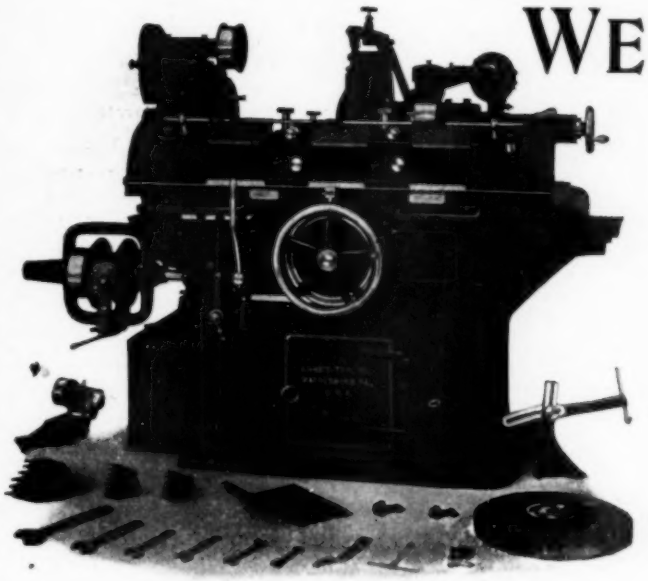
Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Engine Co., Stamford, Conn.

Engines, Oil
Remington Oil Engine Co., Stamford, Conn.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Garden City Fan Co., Chicago, Ill.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.



WE LAY THE PROOF BEFORE YOU

We show here but one Landis Grinding machine and a few illustrations of what a Landis does.

We make something like 50 sizes, one of which will positively meet your needs in a far better, cheaper and more economical way than your present method of doing things.

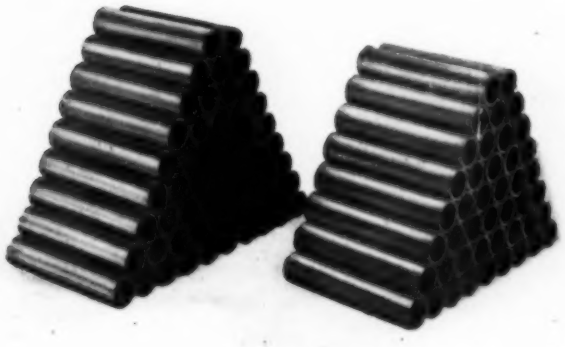
Look over the jobs illustrated below, note the time taken to do the work, and should your line not be shown, you certainly know that a machine making this showing can do something for you.

It will cost you nothing to have one of our experts call.

Time saved is money earned.

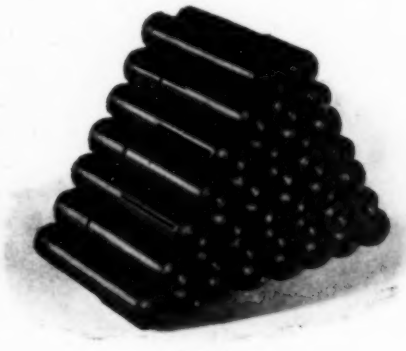
59 Pieces.

Cast iron automobile gas engine pistons 4½" Dia. 5½" long ground to size within .0005 limit of variation, .025 removed. Average time 5 minutes.



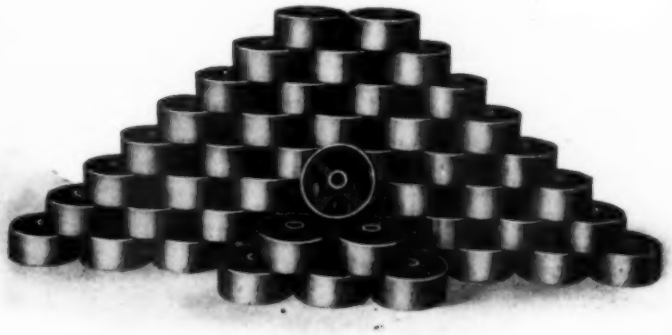
98 Pieces.

Cast iron drums 3" Dia. 15" long, ground from rough castings, size within .005 limit of variation, 1/8" to 3/16" removed. Average time 10 minutes.



35 Pieces.

Hardened steel spindles 1⅞" and 2⅛" Dia., 8¾" long, size within .0005 limit of variation. .035 removed. Average time 19 minutes.



50 Pieces.

Crowned pulleys 8" Dia. 3½" face ground from rough castings, size within .010 limit of variation, ⅛" removed. Average time 12 minutes.

LANDIS TOOL CO., Waynesboro, Pa., U. S. A.

AGENTS—W. E. Flanders, 309 Schofield Building, Cleveland, O., and 933 Monadnock Block, Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

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Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric

Crocker - Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Buffalo Forge Co., Buffalo, N. Y.
Crocker - Wheeler Co., Ampere, N. J.
Garden City Fan Co., Chicago, Ill.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Fire Brick

McLeod & Henry Co., Troy, N. Y.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Stow Mfg. Co., Binghamton, N. Y.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery

Scranton Co., The, New Haven, Conn.

Forgings, Drop

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
Krupp (Thos. Prosser & Son), New York.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic

Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine

Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel

Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Krupp (Thos. Prosser & Son), New York.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Phila., Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Byram & Co., Inc., Detroit, Mich.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co, New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.
Witteman & Co., A. P., Phila., Pa.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester, City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam

Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Carey, Samuel, Glendale, L. I.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Foster Kimball Mach. Co., Elkhart, Ind.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Perkins Mfg. Co., Springfield, Mass.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.

Gears, Rawhide—*Continued.*

New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Carey, Samuel, Glendale, L. I.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets

Burke Electric Co., Erie, Pa.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas

American Gas Furnace Co., New York.

Gibs

Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cock

Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter

Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.

Speeds and Feeds for Screw Machine Work*

A Record of Speeds and Feeds Employed in Machining Various Classes of Materials in the Automatic Screw Machine

BY C. L. GOODRICH‡ AND F. A. STANLEY†

The ordinary class of screw-machine tools, suitable speeds and feeds for which have to be determined when camming automatics, includes the various turning tools such as box tools (adjustable and non-adjustable), hollow mills, drills, reamers, counterbores, taps and dies, forming and cutting-off tools. The accompanying tables of speeds and feeds for different types of tools used on materials commonly worked in the automatic have been compiled from data accumulated and thoroughly tested during extended experience in this class of work, and have proved of value in the screw-machine department, not only in connection with the handling of automatics, but also, to a considerable extent, on hand machines, although, naturally, the matter of feeds on the latter class of apparatus is largely regulated by the personal equation; the question of spindle speeds, however, is quite as important and as readily settled for hand machines as for autotatics.

CUTTING SPEEDS AND FEEDS FOR SCREW STOCK.

1/32 Inch Chip				1/16 Inch Chip				1/8 Inch Chip			
Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.
1/8	80	2445	.002	1/8	60	916	.0035	3/8	55	560	.004
5/16	70	1426	.003	3/16	60	611	.004	1/2	55	420	.005
1/4	70	1069	.004	1/4	60	458	.005	3/4	55	280	.006
3/8	70	713	.005	5/16	55	280	.006	1	50	191	.007
1/2	60	458	.006	1	55	210	.007	1 1/4	50	152	.007
3/4	60	305	.007	1 1/4	55	168	.007	1 3/8	45	114	.007
1	60	229	.008	1 3/8	50	127	.008	1 3/4	45	98	.007
1 1/4	60	183	.008	1 1/2	50	109	.008	2	40	76	.008
1 3/8	50	127	.009	2	45	86	.009	2 1/4	40	68	.008
1 3/4	50	109	.010	2 1/4	45	76	.009	2 3/8	40	61	.008
2	50	95	.010	2 3/8	45	68	.009	3	40	51	.008
2 1/4	50	85	.010	3	45	57	.009	3 3/8	40	44	.008

1/16 Inch Chip				1/8 Inch Chip				1/4 Inch Chip			
Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.
3/8	50	382	.004	3/4	50	254	.004	1 1/8	45	137	.005
1/2	50	254	.005	1	50	191	.005	1 3/8	45	114	.005
1	50	191	.005	1 1/8	45	137	.005	1 3/4	45	98	.005
1 1/4	45	137	.006	1 3/8	45	114	.006	2	40	76	.006
1 3/8	45	114	.006	1 3/4	45	98	.006	2 1/4	40	68	.006
1 3/4	45	98	.006	2	40	76	.006	2 3/8	40	61	.007
2	40	76	.007	2 1/4	40	68	.007	3	40	51	.007
2 1/4	40	68	.007	2 3/8	40	61	.007	3 3/8	40	44	.007
2 3/8	40	61	.007	3	40	51	.007	4	40	38	.008
3	40	51	.007	3 3/8	40	44	.007	4 3/8	40	34	.008

TABLE 1. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

It is, of course, impossible, where a series of tools is used on an automatic machine providing say two rates of speed for the spindle for any given job, to select speeds theoretically correct for each and every tool carried by the turret and cross slide. A compromise is necessary and therefore speeds are selected which will fall within the range suitable for the different tools; in determining these surface speeds and the rates at which to drive the spindle to approximate closely the desired surface velocities, the tables should be found of service.

Speeds and Feeds for Turning

Tables 1 and 2 cover turning speeds and feeds for bright-drawn stock (screw stock) and brass, with various depths of chip (that is, stock removed on a side) from 1/32 inch up to 3/8 inch. These feeds and speeds and depths of cut are figured more especially for such tools as roughing boxes where the cut, though frequently heavy, is taken by a single cutting edge, the work being well supported behind the cutter during the operation. Table 3 covers the same range of steel work as Table 1, but is laid out for hollow-mill operations; it will be noticed that, the cut being divided with this tool among three or more cutting edges, coarser rates of feed are provided for than with the box tool. With both classes of tools the feeds are, of course, increased as the diameter of the stock increases, the peripheral speeds being reduced as the feeds grow coarser and the chip greater in depth.

The speeds and feeds for finishing box tools as used on different materials are given in Table 4, the last column indicatting the amount of stock which, generally speaking, it is advisable to remove in order to produce a good surface.

Forming-tool Speeds and Feeds

Speeds and feeds for forming tools are given in Table 5, the widths covered here ranging from 1/16 inch to 2 inches, and the smallest diameter of form from 1½ inches down to 1/16 inch. It will be seen that the tool about ⅛ inch wide is adapted to take the coarsest feed, tools from this width up to about 3/16 (such as are commonly employed for cutting-off purposes) admitting of heavier crowding, as a rule, than either the narrower or wider tools. Thus we see the rate of feed drop off as the tool narrows to 1/16 inch, which obviously is too thin a cutting device to admit of taking much of a chip, while similarly as the width of form and chip increases above about 3/16 or ¼ inch the rate of feed must again be diminished to give the best results. Naturally, other

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things being equal, the greater the diameter of the section formed, the coarser the feed which can be taken economically. This is also indicated by the figures in the table.

Drilling and Reaming Data

Drilling speeds and feeds are given in Table 6. While these speeds are based on much higher peripheral velocities than drillmakers as a rule recommend for general purposes, it should be remembered that conditions for drilling in the automatic on the usual run of work are nearly ideal so far as concerns matters of lubrication of drill and work, steadiness of feed, etc., and it is possible under these conditions where the holes drilled as a rule are comparatively shallow and the drill has ample opportunity for cooling during the operations carried on by the other tools, to maintain speeds that would be considered too high to be attempted in general shop practice.

Table 7 is made up of speed and feed data for reamers. In this table the feed for different classes of material has been considered as constant for any given diameter of reamer, although it is conceivable that with certain materials, especially on brass alloys, etc., the feed per revolution might be increased somewhat, to advantage, over the rates given. These feeds have been tabulated, however, as representing highly satisfactory practice in reaming the materials listed.

Threading, Counterboring, Etc.

Table 8 explains itself and, while giving speeds for threading work with dies, should be of equal value in establishing speeds for tapping.

For feeds for counterbores from ⅜ inch to 2 inches diameter, Tables 1 and 2 for turning may be followed where the counterbores cut to a depth from one-half to three-quarters their diameter. Where cutting deeper than about one diameter, the feeds should be decreased; in such depths it is well to withdraw the counterbore during the cutting operation to free it from chips.

It is not expected that the speeds and feeds laid down in these tables will coincide exactly with the ideas of everybody engaged in screw-machine operations. Conditions as to materials, lubricants, clearances of cutting edges, quality of tools, etc., all have an important bearing upon the question of efficient cutting speeds and feeds. It is believed, however, that the foregoing information should be of service to a good many readers, representing as it does the practice commonly followed by one of the largest tool shops with its carbon-steel screw-machine tools.

The direct application of jets of dry steam to a gravel bank, through the agency of driven pipes, has been found to be an efficient method for thawing frozen gravel.

Power Required to Drive Individual Machine Tools

By H. B. Emerson*

The above subject is one which has received a great deal of attention, but little has been written which has been of service to the ordinary user of machine tools. There has been a reason for this, however, and it is the purpose of this article to touch on the every-day side of the situation and show to the users the engineers' position in the matter.

In years past, when shops used no better tool steel than mushet, it was fairly easy to state what power would be required to drive a certain tool, as general shop practice at that time was nearly the same throughout the whole country, and the amount of power required to do the cutting was not much greater than that required to overcome the friction of the moving parts. There existed a fairly definite relation between the amount of metal removed and the amount of power required to remove it, for each type of tool; and Professor Flather, after exhaustive tests, issued very complete formulas for approximating the power required to drive any tool. With the introduction, however, of the high-carbon and self-hardening tool steels, together with the great wave of prosperity which has swept the country for the past few years, matters have changed materially. New conditions have arisen, cutting speeds have been attained which were never before thought of, competition and the great demand for finished products have caused the manufacturers to work every machine to the utmost; although many mechanical and electrical engineers have made exhaustive tests and studied the situation thoroughly, up to the present time no formulas have been promulgated which could be given to the uninitiated to apply to machine tools in general.

No hard and fast rule can be set forth

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CUTTING SPEEDS AND FEEDS FOR BRASS

1/32 Inch Chip				1/16 Inch Chip				1/8 Inch Chip			
Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.
1/16	180	5500	.003	1/16	180	2748	.004	1/16	165	1680	.004
3/32	180	3908	.004	3/32	180	1833	.005	1/8	165	1260	.006
1/8	180	2748	.006	1/8	180	1374	.0065	1/4	165	840	.007
3/16	180	1833	.006	3/16	165	840	.0075	1	150	573	.008
1/4	180	1374	.008	1	165	630	.0085	1 1/4	150	456	.009
1/4	180	915	.010	1 1/16	165	504	.010	1 1/8	135	342	.010
1	180	687	.011	1 1/8	150	381	.012	1 3/4	135	294	.010
1 1/16	180	549	.012	1 1/4	150	327	.012	2	120	228	.011
1 1/8	150	254	.014	2	135	258	.014	2 1/4	120	204	.011
1 1/4	150	218	.014	2 1/4	135	228	.014	2 1/8	120	183	.012
2	150	190	.015	2 1/8	135	204	.014	3	120	153	.012
2 1/4	150	170	.015	3	135	171	.014	3 1/8			

3/16 Inch Chip				1/4 Inch Chip				3/8 Inch Chip			
Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.
3/16	150	1146	.005	1/4	150	762	.005	1 1/4	135	411	.007
1/4	150	762	.006	1	150	573	.006	1 1/8	135	342	.008
1	150	573	.007	1 1/8	135	411	.007	1 1/4	135	294	.008
1 1/16	135	411	.008	1 1/8	135	342	.008	2	120	228	.009
1 1/8	135	342	.009	1 1/4	135	294	.008	2 1/4	120	204	.009
1 1/4	135	294	.009	2	120	228	.009	2 1/8	120	183	.010
2	120	228	.010	2 1/4	120	204	.009	3	120	153	.010
2 1/4	120	204	.010	2 1/8	120	183	.010	3 1/8	120	131	.010
2 1/8	120	183	.010	3	120	153	.010	4	120	114	.010
3	120	153	.010	3 1/8	120	131	.010	4 1/8	120	102	.010

TABLE 2. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

to meet all cases, as the power required varies with the kind of metal worked, with the kind of tool steel and machine used, with the shape and size of the chip removed, with the cutting speed and with several other conditions, which are bound to vary with different usage. Neither can a person state, with accuracy, that it requires a certain size of motor for a given tool, because the duty required of that tool in one shop or factory may be more severe than in another. For example, a 36-inch lathe used in one shop for roughing shafting of low-carbon steel, where they use two cutting tools, reduces the diameter of the shaft ¾ inch per cut, with ⅛-inch feed and a cutting speed of 150 feet per minute, and will require, approximately, a 25 horse-power motor to run it. In another shop the same size of lathe may be used for finishing and other light work and will require perhaps a three horse-power but never more than a five horse-power motor to drive it under any condition. In large factories, or in those factories having keen competition, the tools are worked to their utmost; while in repair shops and small factories, where the conditions are entirely different, the service of the tools is much less severe and in general it requires much less power to drive them.

From the above facts it will be readily seen why no accurate data have been published. The writer, however, after making many tests of the power required to drive machine tools, has gathered some data

SPEEDS AND FEEDS FOR HOLLOW MILLS. SCREW STOCK.

1/32 Inch Chip				1/16 Inch Chip				3/32 Inch Chip			
Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min	Feed per Rev.
⅛	80	2445	.0026	¼	60	916	.0045	⅜	55	560	.0052
3/16	70	1426	.0039	⅜	60	611	.0052	⅜	55	420	.0065
¼	70	1069	.0052	½	60	458	.0065	¾	55	280	.0078
⅜	70	713	.0065	¾	55	280	.0078	1	50	191	.0091
½	60	458	.0078	1	55	210	.0091	1⅛	50	152	.0091
¾	60	305	.0091	1¼	55	168	.0091	1⅜	45	114	.0091
1	60	229	.0104	1⅜	50	127	.0104	1½	45	98	.0091
1¼	60	183	.0104	1¾	50	109	.0104	2	40	76	.0104
1½	50	127	.0117	2	45	86	.0117	2¼	40	68	.0104
1¾	50	109	.013	2¼	45	76	.0117	2⅜	40	61	.0104
2	50	95	.013	2⅜	45	68	.0117	3	40	51	.0104
2¼	50	85	.013	3	45	57	.0117	3⅜			

3/16 Inch Chip				¼ Inch Chip				5/16 Inch Chip			
Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Dia. of Stock	Feet Surface Speed	Rev. per Min.	Feed per Rev.
⅜	55	420	.0052	¾	50	254	.0052	1⅛	45	137	.0065
½	55	280	.0065	1	50	191	.0065	1⅜	45	114	.0065
1	55	210	.0065	1¼	45	137	.0065	1¼	45	98	.0065
1¼	50	152	.0078	1⅜	45	114	.0078	2	40	76	.0078
1⅜	50	127	.0078	1¾	45	98	.0078	2¼	40	68	.0078
1¾	50	109	.0078	2	40	76	.0078	2⅜	40	61	.0078
2	40	76	.0091	2¼	40	68	.0091	3	40	51	.0078
2¼	40	68	.0091	2⅜	40	61	.0091				
2⅜	40	61	.0091	3	40	51	.0091				
3	40	51	.0091								

TABLE 3. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

CUTTING SPEEDS AND FEEDS FOR FINISH BOX TOOL

Finished Diameter of Work	Screw Stock			Brass Rod			Cast Iron			Tool Steel			Amount of Stock to remove on a Side
	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Feet Surface Speed	Rev. per Min.	Feed per Rev.	Feet Surface Speed	Rev. per Min.	Feed per Rev.	
1/16	80	4889	.003	180	11000	.003				40	2445	.002	.002
⅛	80	2445	.0045	180	5500	.0045				40	1222	.003	.0025
3/16	70	1426	.0055	180	3668	.0055	70	1426	.0055	40	815	.003	.0025
¼	65	993	.0075	180	2750	.0075	70	1069	.0075	35	581	.004	.0045
⅜	60	458	.011	180	1375	.011	65	496	.011	35	267	.005	.006
½	60	305	.012	180	917	.012	65	331	.012	35	178	.007	.006
1	60	229	.012	175	668	.012	60	229	.014	30	115	.009	.0065
1½	55	140	.014	170	433	.014	60	153	.016	30	76	.009	.007
2	50	95	.014	170	325	.014	60	115	.016	30	57	.009	.008

TABLE 4. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

HORSE-POWER FOR DRILLS

	H. P.
Sensitive drills	¼
12-inch to 20-inch upright drills	1
20-inch to 24-inch upright drills	1½
26-inch to 30-inch upright drills	2½
30-inch to 40-inch upright drills	3½
36-inch to 40-inch radial drills	1½
4-foot to 5-foot radial drills	2
6-foot to 8-foot radial drills	3 to 5

HORSE-POWER FOR LATHES

	H. P.
Speed lathes	1
22-inch and 24-inch engine lathes	2
26-inch and 30-inch engine lathe	2½
36-inch and 42-inch engine lathes	3½
48-inch and 54-inch engine lathes	5
60-inch engine lathes	6
72-inch engine lathes	7½
84-inch engine lathes	10

HORSE-POWER FOR HEAVY-DUTY LATHES

	H. P.
24-inch to 30-inch lathes	15
36-inch to 48-inch lathes	20
54-inch to 72-inch lathes	25

HORSE-POWER FOR BORING MILLS

	H. P.
37-inch boring mill	4
51-inch boring mill	5
5-foot boring mill	6
6-foot boring mill	7½
7-foot to 9-foot boring mills	10
10-foot boring mill	12
12-foot to 16-foot boring mills	15
16-foot to 25-foot boring mills	18

HORSE-POWER FOR PLANERS

	H. P.
20x20-inch by 6-foot single-head planer	3½
30x30-inch by 8-foot single-head planer	5
42x42-inch by 10-foot single-head planer	7½
60x60-inch by 12-foot double-head planer	10
72x72-inch by 14-foot double-head planer	15
84x84-inch by 18-foot double-head planer	20
9x10x24-foot double-head planer	30
12x12x24-foot double-head planer	40

HORSE-POWER FOR CRANK SLOTTERS

	H. P.
12-inch stroke	5
18-inch stroke	7½
24-inch stroke	10
30-inch stroke	10

HORSE-POWER FOR SHAPERS*

	H. P.
16-inch stroke	2
24-inch stroke	3
30-inch stroke	5

*Single-head machines.

HORSE-POWER FOR HORIZONTAL MILLING MACHINES

	H. P.
24 inches between housings	7½
36 inches between housings	10
42 inches between housings	15
4 to 6 feet between housings	15 to 20

which may be of use to many readers if used with judgment; for the duty in general required of machine tools in small factories, repair shops and the like, the accompanying horse-powers for the various machine tools will be found to be approximately correct:

The above powers are the average results from a great many tests of individually driven machines working under general machine-shop duty; if tools are to be grouped, 40 to 85 per cent. of the above powers may be used to figure the proper capacity of the motor or engine which will be used to drive the group, using a higher or lower percentage according to the total number of machines which will be used under maximum duty at any one time.

If a manufacturer expects to equip his machine shop with individually driven machine tools and run them under heavy duty, that is, to work them at their maximum capacity, using high-carbon cutting tools, I would recommend that he employ a skilled engineer to draw his specifications for the equipment, in order that he may have sufficient power at all times for his maximum duty and yet not have motors which are entirely too large for the general run of his work.

Piece-work Rates and Premiums

By W. H. Booth

At one time I had very much work to carry out which it was impossible to fit in the slightest degree with any piece-rate system, but experience showed me that the rate of progress was much less than it very well might be without sacrifice of good workmanship. A day-rate system of pay was universal, and it was by no means the quickest or best man that seemed to get the best pay.

There was no way of estimating the rate of progress possible on any one job, but in the course of a year it was possible to say that ten men had averaged say three units per day. Now if each unit was paid for at the rate of 5 cents in addition to the regular day wages, each man would average an extra pay of 90 cents weekly and so on, according to the rate of premium given. It was easy to come to some rough approximation on each of the different classes of work as to the amount of premium to be paid. Observe, the man always received his regular daily wage. He got this in fair weather or foul, whether he made specially good progress or whether on account of some accident he made no progress at all.

The intended premium was to serve simply as an inducement to keep things going, to cut out the numerous trifling delays and easing up that so seriously interfered with progress. So it was arranged that for each unit of work done a small premium or bonus should be paid above and in addition to the weekly wage. The experiment was started with a man who seemed a likely sort of a subject, for he always seemed very keen on money. He was what is known as an unskilled man and he was that rare survival, an illiterate. His ideas on money were certainly peculiar. If his time worked out to 39 shillings wages and he was given 40 shillings in gold and asked to hand over the odd shilling in change, he was quite put out. He seemed to feel he was being in some way defrauded.

This man was put upon the new system and a small bonus rate was fixed upon. The system was explained to him and he was plainly told that he would always receive his customary hourly rate and the small bonus in addition. All went well the first week, for he made a bonus of about six shillings, or $1.50. Next week he made only a dollar, or four shillings, additional and the trouble begun. Why had he not received as much as last week? He had

REAMING FEEDS AND SPEEDS

Dia. of Reamer	Feed per Rev.	Amount to Remove on Dia.	Rev. per Min. Screw Stock at 40 Ft.	Brass Rod at 130 Ft.	Cast Iron at 45 Ft.	Tool Steel at 25 Ft.	Dia. of Reamer	Feed per Rev.	Amount to Remove on Dia.	Rev. per Min. Screw Stock at 40 Ft.	Brass Rod at 130 Ft.	Cast Iron at 45 Ft.	Tool Steel at 25 Ft.
1/8	.005	.0045	1222	3972	1375	764	1¼	.018	.010	122	397	138	76
3/16	.006	.0045	815	2648	917	509	1⅜	.020	.010	102	331	115	63
¼	.007	.006	611	1986	688	382	1½	.022	.010	87	284	98	54
5/16	.0085	.006	407	1324	458	254	2	.024	.013	76	248	86	48
⅜	.0105	.008	306	993	344	191	2¼	.026	.013	68	220	76	42
7/16	.012	.008	245	795	275	153	2½	.028	.013	61	199	69	38
½	.014	.008	204	662	229	127	2¾	.030	.013	56	181	63	35
1	.016	.010	153	497	172	95	3	.032	.013	51	165	57	32

TABLE 7. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

SPEEDS FOR FORMING

Dia. of Work	Screw Stock		Brass Rod		Cast Iron		Tool Steel	
	Feet Surface Speed	Rev. per Min.	Feet Surface Speed	Rev. per Min.	Feet Surface Speed	Rev. per Min.	Feet Surface Speed	Rev. per Min.
1/16	75	2292	200	6112				
1/8	75	1528	200	4074				
¼	70	1069	185	2827	75	1146	45	688
⅜	65	662	185	1885	70	713	40	407
½	65	497	185	1414	70	535	40	306
¾	60	305	175	882	65	331	35	178
1	60	229	175	667	65	248	35	134
1⅛	60	153	170	432	60	153	30	76
2	50	96	170	324	60	115	30	57

FEEDS FOR FORMING TOOLS

Width of Form	Smallest Diameter of Form							
	1/16	1/8	3/16	¼	3/8	½	¾	1⅛
1/16	.0007	.0008	.001	.0012	.0012	.0012	.0012	.0012
1/8	.0005	.0008	.001	.0012	.0015	.0020	.0025	.0025
¼		.0007	.001	.001	.0015	.0015	.0018	.0018
5/16			.0009	.001	.001	.0012	.0015	.0015
⅜			.0008	.0009	.001	.001	.0015	.0015
¾				.0008	.0009	.001	.0011	.0012
1					.0008	.0009	.001	.0012
1⅛					.0007	.0007	.0009	.0011
2							.0007	.001

TABLE 5. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

SPEEDS FOR DIES - STANDARD THREADS.										
Dia. of Thread	Screw Stock		Brass Rod		Cast Iron		Tool Steel		Cast Brass	
	Feet Surface Speed	Rev. per Min.	Feet Surface Speed	Rev. per Min.	Feet Surface Speed	Rev. per Min.	Feet Surface Speed	Rev. per Min.	Feet Surface Speed	Rev. per Min.
⅛	40	1222	135	4126	40	1222	25	764	120	3666
¼	40	611	125	1909	40	611	25	382	110	1680
⅜	35	356	120	1222	35	356	20	204	100	1019
½	35	267	120	917	35	267	20	153	100	764
⅝	35	178	115	586	30	153	20	102	100	509
1	30	115	110	420	30	115	20	76	90	344
1¼	30	92	100	306	25	76	15	46	90	275
1½	30	76	90	229	25	64	15	38	90	229
2	25	48	85	162	20	38	15	29	90	172

TABLE 8. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

already commenced to regard his total receipts last week as his regular rate of pay and he regarded the smaller bonus of the second week as an attempt to lower his wages. It was found to be impossible to bring him to reason; the end of the whole matter was that by his own request he was continued simply at the old day rate, no bonus was paid him and my well intentioned efforts fell through.

Here there was no question or possibility of the rate being cut. The man in any case would receive more than his day wages, for there was not even a minimum day's progress fixed before the bonus should begin. It began at once; it was wholly additional on the smallest progress and was aimed to return a man about 5 per cent. increase if the previous average of progress had been kept up, while it gave him a chance of occasionally doubling or trebling a week's pay should he be the one favored with a special run of luck such as did occasionally turn up. I have mentioned this, perhaps exceptional instance of a peculiar mode of thought as an illustration of the way that men's minds may occasionally work.

I was never fully able to grasp just how this particular man's mind got to work. He was fairly greedy for money, yet he went back to his ordinary day rate only without a grumble. What he did not appear capable of standing was an irregular rate of pay, even though all the irregularity was additional and there was no subtraction. Something of his peculiarity may have been due to his illiteracy, but at the same time there may be a streak of a similar mode of thought in the mind of other men who are not illiterate; it may be that this strain has something to do with piece-rate troubles.

My own cleverness appealed to me vastly, for I had discovered a method of expediting work and helping a man's wages by which he would win every time, and the absolute failure of the scheme rather gave a set-back to my self-esteem. Piece rates I could very well understand might be unpopular, because they started out on a basis of compelling a man to step lively in order to make even his ordinary day rate of pay. But I made no call on a man's superfluous energy to earn his regular pay. He got that by my scheme and did nothing some days when things went wrong, but as an incentive to keep things moving he got an extra for all work done. The scheme would not work a little bit. All I got out of it was an insight into the ways in which some men's minds may work; into the suspicions and misunderstandings that may arise from even the simplest schemes; into the difficulty of dealing with minds of the very sluggish or extremely conservative order. The experience may be useful to others when difficulty arises.

DRILLING FEEDS AND SPEEDS																
Screw Stock			Brass Rod		Cast-Iron		Tool Steel		Screw Stock			Brass Rod		Cast-Iron		Tool Steel	
Dia. of Drill	Feed per Rev.	R.P.M. at 60 Ft. Peripheral Speed	Feed per Rev.	R.P.M. at 175 Ft. Peripheral Speed	Feed per Rev.	R.P.M. at 60 Ft. Peripheral Speed	Feed per Rev.	R.P.M. at 35 Ft. Peripheral Speed	Dia. of Drill	Feed per Rev.	R.P.M. at 55 Ft. Peripheral Speed	Feed per Rev.	R.P.M. at 165 Ft. Peripheral Speed	Feed per Rev.	R.P.M. at 55 Ft. Peripheral Speed	Feed per Rev.	R.P.M. at 33 Ft. Peripheral Speed
1/32	.0006	7333	.0008	21390	.0006	7333	.0005	4278	3/8	.005	420	.0065	1200	.005	420	.0037	252
3/64	.0008	4889	.0010	14260	.0008	4889	.0006	2852	7/16	.0057	373	.0074	1120	.0057	373	.0043	224
.059	.001	3884	.0013	11329	.001	3884	.0008	2265	29/64	.0057	353	.0074	1067	.0057	353	.0043	212
1/16	.0013	3667	.0017	10696	.0013	3667	.0010	2139	15/32	.0050	330	.0077	1008	.0059	330	.0044	202
5/64	.0016	2993	.002	8555	.0016	2993	.0012	1658	31/64	.006	305	.0078	917	.006	305	.0045	183
3/32	.0018	2445	.0023	7130	.0018	2445	.0014	1430	1/2	.0065	280	.0084	840	.0065	280	.0049	169
.105	.002	2186	.0026	6366	.002	2186	.0015	1305	33/64	.007	258	.0091	776	.007	258	.0052	155
7/64	.0025	1833	.0033	5348	.0025	1833	.0018	1070	17/32	.0075	240	.0097	702	.0075	240	.0056	144
.150	.003	1528	.0039	4456	.003	1528	.0022	891	35/64	.008	224	.0104	672	.008	224	.006	134
9/64	.003	1421	.0039	4144	.003	1421	.0022	828			50 Ft.		150 Ft.		50 Ft.		30 Ft.
5/32	.004	1222	.0052	3565	.004	1222	.003	713	1	.0085	191	.0110	573	.0085	191	.0064	115
11/64	.004	1048	.0052	3050	.004	1048	.003	611	1 1/16	.009	169	.0117	509	.009	169	.0067	102
1/4	.0045	916	.0058	2674	.0045	916	.0033	535	1 1/8	.0095	152	.0123	458	.0095	152	.0071	92
17/64	.0045	815	.0058	2377	.0045	815	.0033	475	1 3/16	.010	139	.0130	416	.010	139	.0075	83
9/32	.0045	733	.0058	2139	.0045	733	.0033	427	1 1/4	.011	127	.0143	382	.011	127	.0082	76
5/16	.0045	611	.0061	1783	.0045	611	.0035	356	1 5/16	.012	118	.0156	352	.012	118	.009	70
21/64	.005	524	.0065	1528	.005	524	.0037	305	1 3/4	.013	109	.0169	327	.013	109	.0097	65
									2	.014	96	.0182	294	.014	96	.0105	57

TABLE 6. SPEEDS AND FEEDS FOR SCREW MACHINE WORK

Interference in Involute Gears

By C. C. Stutz

While the general principles governing the interference of involute gears are well known, the following graphical demonstrations, formulas and plotted diagrams may place this general information in more efficient form for the use of many.

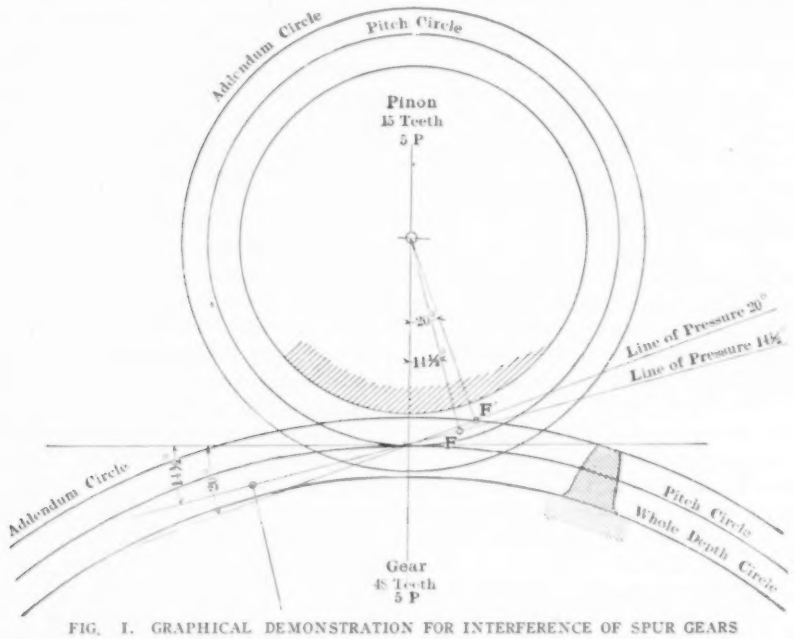


FIG. 1. GRAPHICAL DEMONSTRATION FOR INTERFERENCE OF SPUR GEARS

Fig. 1 shows a graphical demonstration of the interference of a 5-pitch, 15-tooth true involute form spur pinion and a 5-pitch, 48-tooth mating gear. The point F is the right-angled intersection of a line drawn from the center of the pinion, and at an angle of 14½ degrees with the common center line of the pinion and gear, with the line of pressure which is drawn through the point of tangency of the two pitch circles and at an angle of 14½ degrees to the common tangent at that point. If this point falls within the addendum circle of the meshing gear, the tooth of the meshing gear will interfere from this point up to its addendum circle. Therefore from this point on the curve must be corrected to overcome it.

If the point F falls on or outside of the addendum circle of the meshing gear no interference will result. The point F' for an angle of obliquity of 20 degrees falls on the addendum circle and thus the gear and pinion indicated in the illustration would mesh without interference for this angle.

Formula for Locating the Point of Interference of Spur Gears

Referring to Fig. 2:

Let $AF = c$.
$AB = r_2$.
$AD = d$.
$BE = r_1$.
$DE = f$.
α = the angle of tooth pressure.
y = the distance from the center of the gear to the point at which interference begins.
x = the distance from the point at which interference begins to the addendum circle of the gear measured along a radius.
O = the perpendicular distance from the point at which interference begins to the center line of the pinion and gear.

Then
r_1 = the pitch radius of the gear.
r_2 = the pitch radius of the pinion.
P = the pitch diameter of the gear.
d_1 = the outside diameter of the gear.

Then
$$c = r_2 \cos \alpha, \text{ and}$$
$$d = c \cos \alpha = r_2 \cos^2 \alpha.$$

Now
$$f = r_1 + r_2 - d.$$
$$= r_1 + r_2 (1 - \cos^2 \alpha),$$

and
$$O = c \sin \alpha = r_2 \sin \alpha \cos \alpha.$$

Now
$$y^2 = f^2 + O^2 \text{ and } y = \sqrt{f^2 + O^2}.$$

Then by substituting
$$y = \sqrt{[r_1 + r_2(1 - \cos^2 \alpha)]^2 + (r_2 \sin \alpha \cos \alpha)^2}$$

For a pressure angle of 14½ degrees
$$y = \sqrt{(r_1 + 0.0627\, r_2)^2 + (0.2424\, r_2)^2},$$
and
$$x = \frac{d_1}{2} - y.$$

For a pressure angle of 20 degrees
$$y = \sqrt{(r_1 + 0.1169\, r_2)^2 + (0.3214\, r_2)^2},$$
and
$$x = \frac{d_1}{2} - y.$$

Solving for x and y will give the point of interference for any particular case.

Diagram for Location of Interference

Fig. 3 shows a diagram giving the location of the point of the beginning of interference for one diametral pitch involute gears from 10 to 135 teeth meshing with a 12-tooth pinion. The ordinates are the distances from the point where interference commences to the addendum circle of the gear measured along the radius. They correspond to the quantity x in the preceding equations. From this point to the addendum circle the tooth outline must be corrected.

The upper curve A is for a pressure angle of 14½ degrees and an addendum of 0.3183 × circular pitch. The second B is for the same pressure angle and a shorter addendum, 0.25 × circular pitch.

This addendum factor is for what is known as the stubbed tooth standard, a form of tooth which is rapidly coming into use, and was suggested by Charles H. Logue in the American Machinist, Volume 30, Part 1, page 804.

The third curve C is for a pressure angle of 20 degrees and an addendum of 0.3183 × circular pitch; while the lowest one D is for the 20-degree angle and the stubbed tooth addendum.

The diagram as plotted is for one pitch. To find the corresponding ordinate for any other pitch divide the value given in the diagram by the required pitch. The quotient will be the distance desired.

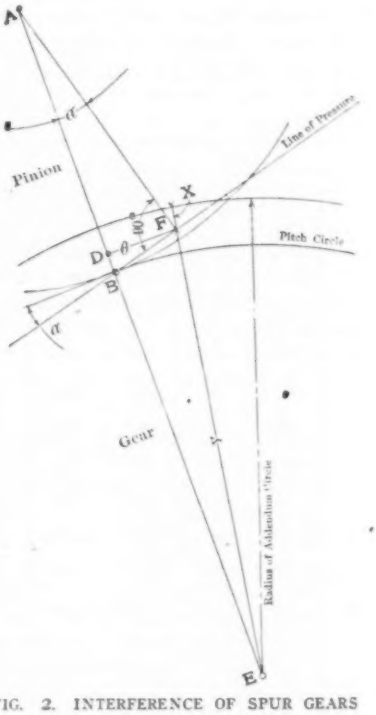


FIG. 2. INTERFERENCE OF SPUR GEARS

Interference of Rack and Pinion

Interference will occur between the teeth of a rack and pinion when the point B, Fig. 4, which is the intersection of a perpendicular from the point O to the line of pressure AL falls inside of the rack

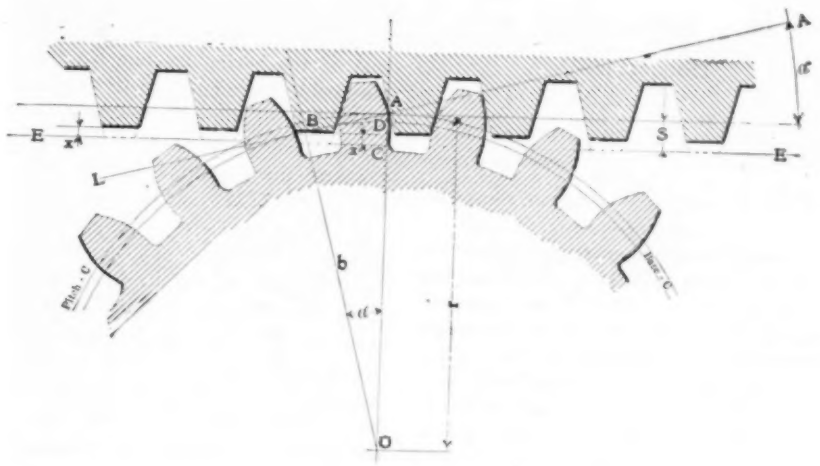


FIG. 4. INTERFERENCE OF GEAR AND RACK

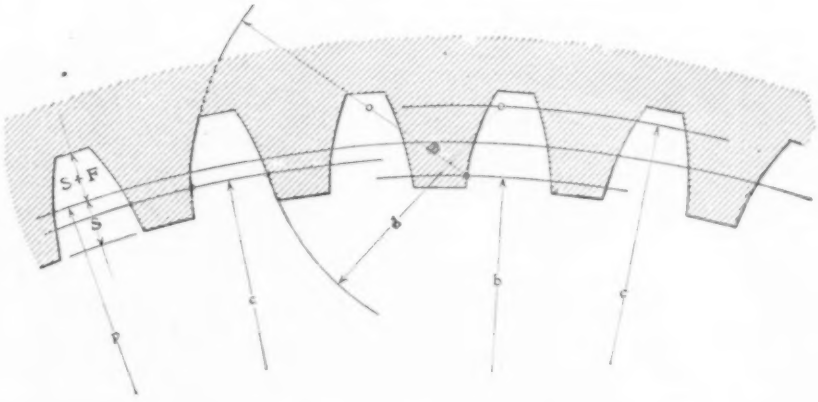


FIG. 5. INTERFERENCE OF INTERNAL GEAR AND PINION

addendum line $E\,E$. In the figure the distance over which interference takes place is $C\,D$. It is usual practice to shorten the rack teeth by the amount of this interference and the following equations give an easy method of computing this distance.

Let

N = the number of teeth in the pinion.
P = the diametral pitch.
r = the pitch radius.
b = the radius of the base circle.

Let

α = the pressure angle.
x = the distance necessary to shorten the addendum of the rack tooth and
s = the normal addendum of the rack tooth.

Then

$$s = \frac{1}{P},$$

$$r = \frac{\frac{1}{2}N}{P},$$

$$b = r\cos\alpha,$$
$$OD = b\cos\alpha,$$
$$OD = r\cos^2\alpha,$$
$$OC = r - s,$$
$$x = OD - OC, \text{ and substituting}$$
$$= r\cos^2\alpha - (r - s)$$
$$= \frac{\frac{1}{2}N}{P}(\cos^2\alpha - 1) + \frac{1}{P};$$

whence

$$x = \frac{1 - \frac{1}{2}N(1 - \cos^2\alpha)}{P}.$$

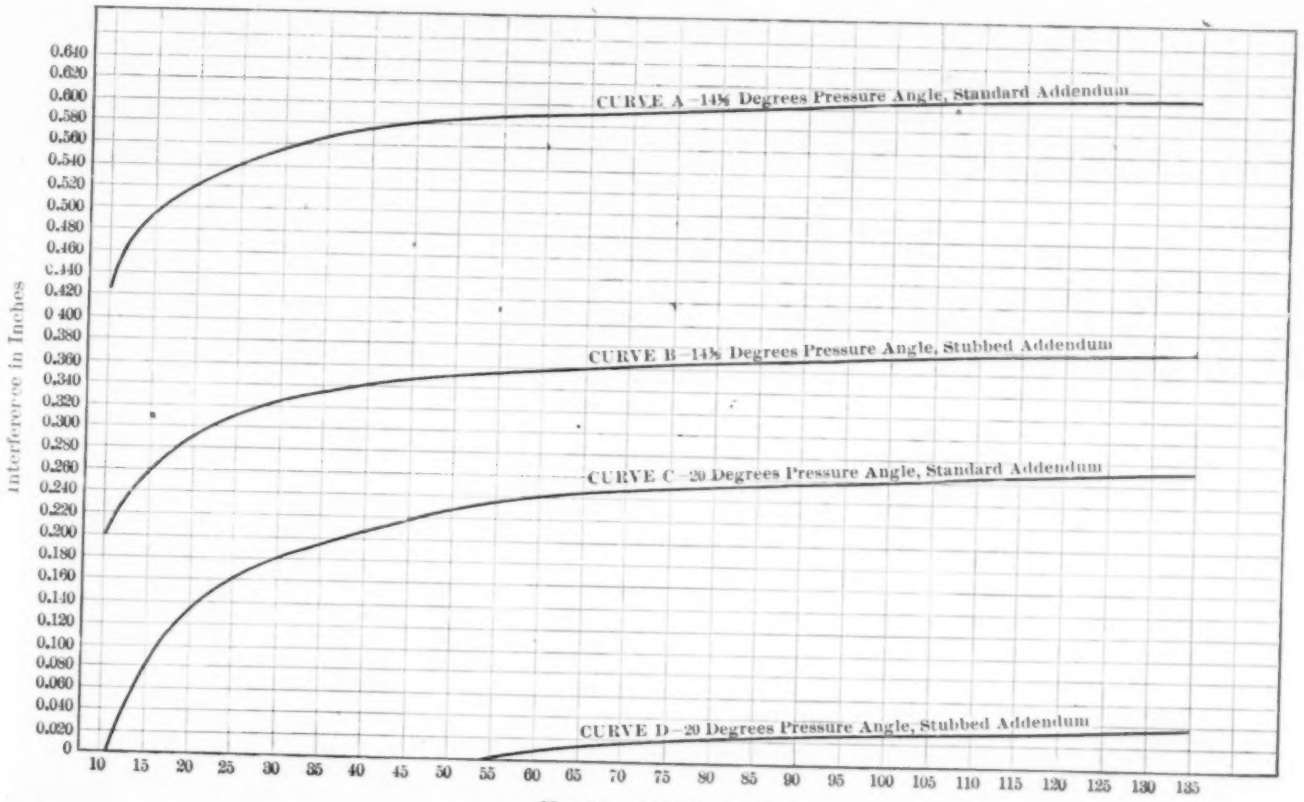


FIG. 3. DIAGRAM SHOWING INTERFERENCE BETWEEN AN INVOLUTE 12-TOOTH, ONE-PITCH PINION AND MATING GEARS FROM 10 TO 135 TEETH

For a pressure angle of 14½ degrees

$$x = \frac{1 - 0.03135\,N}{P}.$$

For a pressure angle of 20 degrees

$$x = \frac{1 - 0.05849\,N}{P}$$

Solving these equations we find that for the true involute form of tooth and a pressure angle of 14½ degrees interference between the teeth of rack and pinion begins with a pinion having 31 teeth. Similarly for a 20-degree pressure angle the interference begins with a pinion of 17 teeth.

Interference of Internal Gear and Pinion

The following method of correction and equations are true for all combinations in which the pinion has less than 55 teeth.

Referring to Fig. 5:

Let

p = the pitch diameter of the gear.
p_1 = the pitch diameter of the pinion.
b = the radius of the base circle.
c = the radius of the correction circle.
d = the radius of the rounding-off circle.
e = the radius of the interference circle.
o = the radius of the tooth outline.
α = the pressure angle.

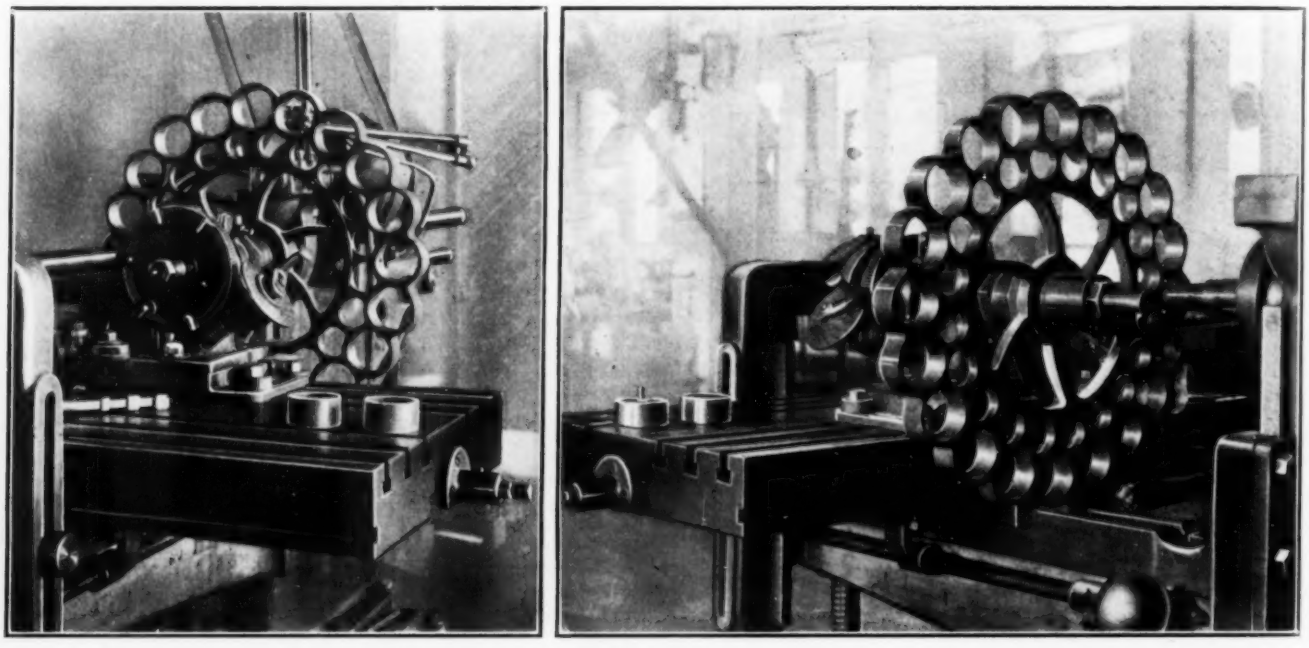
Then

$$d = p \cos \alpha,$$
$$e = \tfrac{1}{2}(b + p),$$
$$c = \frac{p}{\cos \alpha},$$
$$o = \tfrac{1}{4}\,p, \text{ and}$$
$$d = \sqrt{\left(\frac{p}{4}\right)^2 + \left(\frac{p_1}{4}\right)^2}.$$

A Nice Indexing Job on a Boring Mill

Editorial Correspondence

There is sometimes a disadvantage in being too popular or having too good a reputation for doing anything in the way of work that comes along, for something is sure to turn up just when you are very busy on your own work. But it's rather gratifying, just the same, to have other shops say, "Take it to Binsse; Benson can do it." That was how the job shown in the illustrations came to be sent to the Binsse Machine Company. Mr. Benson is the superintendent, one of the many who have graduated from the Brown & Sharpe Company, and who lives up to the reputation quoted.



A NICE INDEXING JOB ON A BORING MACHINE

The work is part of a special machine which the General Electric Company's incandescent-lamp department is building and consists of what might be called a spoked disk with 20 holes in the rim, as shown. The smaller holes inside are not an essential to the device, but were rough bored to remove the skin and help relieve internal strains.

The outer holes are 2⅞ inches in diameter, and their centers lie in about a 21-inch circle. The metal is 1½ inches thick at the rim. When it comes to boring 20 holes of this diameter, and having them all parallel, as well as uniformly spaced, it isn't an easy job on any tool that you usually find in a machine shop.

Being builders of boring machines, they naturally think of that tool first for almost any work; in this case it proved very well adapted to the work to be done.

The first step was to find some good means of indexing the holes. For this purpose the index head of a Brown & Sharpe milling machine was bolted to the table of the boring machine so that the disk could be mounted on its spindle and swing clear of the edge, as shown. This seems the easiest solution of such a problem, and the mounting of the disk required very little time and expense.

A boring bar with a single-point fly cutter was put in the spindle, and an angle casting placed at the front of the table so the disk could be clamped rigidly after indexing. The side of the disk was, of course, faced to allow it to be clamped squarely before beginning the cut. For the roughing cuts, the disk was also clamped at the opposite or back side.

There is very little explanation needed beyond this, as the illustrations show what a really simple job it is, after all, when you go about it in the right way. While it is not possible to do as accurate indexing with the indexing wheel so much smaller than the work, as in this case, it is interesting to note the accuracy obtained. The testing was done by measuring the walls left between the holes; after the second cut, there was only 0.007 inch difference between the thickest and the thinnest wall.

They were at work on the third and last cut when the photographs were taken, and Mr. Benson expected to reduce this error somewhat. But as it stands, it is a job that any mechanic might well feel proud of, and it speaks very well indeed for the accuracy of the indexing head.

F. H. C.

The Australian market showed large gain in the imports of machinery for the first half of the present year, the aggregate reaching the comfortable figure of $6,465,233.

Drop-forging Methods and Interesting Work

How Drop-forgings Are Made with Well Installed Equipment, and Showing Some Difficult Forgings and Their Dies

EDITORIAL CORRESPONDENCE

The impulse to the production of drop forgings, which came from the automobile industry, has aided in the establishing of several new firms in this line, of which the Crescent Forgings Company, of Oakmont, Penn., is one. Its plant is of quite recent construction and has been in operation only a few months. It is our purpose to describe and illustrate some of its methods and work.

Our first half-tone, Fig. 1, shows one corner of the machine shop. This building is of brick, 55x100 feet in general dimensions, and very high-studded, as the illustration shows. The machine tools are all driven by individual electric motors, operating on continuous current and at a pressure of 220 volts. Those which are shown in the illustration are among the largest of the tools used, and when the photograph for our half-tone was taken they were employed on repair work. However, their main use is in producing dies. It is interesting to note the extent to which the boring mill is used for this class of work. In general the turning operations on dies are done on a lathe or with a circular milling attachment on a milling machine. Here, however, the boring mill is used almost entirely for the producing of circular shapes and the boring of holes. On large die work this advantage is obvious, as the unbalancing effect, which is present in a lathe when a hole is being bored considerably out of center of the die block, is done away with by turning the operation over to the mill.

The method of lighting these machine tools is well worthy of notice. Beneath the machine shop is a basement used for storage purposes and the installing of the various piping and wiring systems for the plant. The wiring for each machine tool is taken from this basement through the floor to the motors and lights. The lights are carried on adjustable fixtures which are attached to the machine tools themselves and really form a part of them. One of the main reasons for this method of installation is of course the very great ceiling hight, which would have made it an impracticable proposition to drop lights from the roof structure. The distance from the floor to the under side of the roof truss chords is 32 feet. In addition to this feature, the entire area of the machine shop is served by a traveling crane, which again renders anything in the nature of drop lights or fixtures attached to the ceiling impossible. Aside, however, from these features which made this method of construction necessary for this particular case, it would seem that the general scheme is worthy of wide adoption. In any machine shop it is objectionable to have dangling cords or long ungainly fixtures reaching from the ceiling, in constant danger of being tangled with belting or shafting and in an unhandy position considering the introducing and removing of the work from the machine tool. This method of having an adjustable fixture attached to the machine tool itself and bringing the wiring through the floor would do away with the majority of the objections to the pendant system. A careful inspection of the boring mill in our illustration, Fig. 1, will show this adjustable fixture located between the heads.

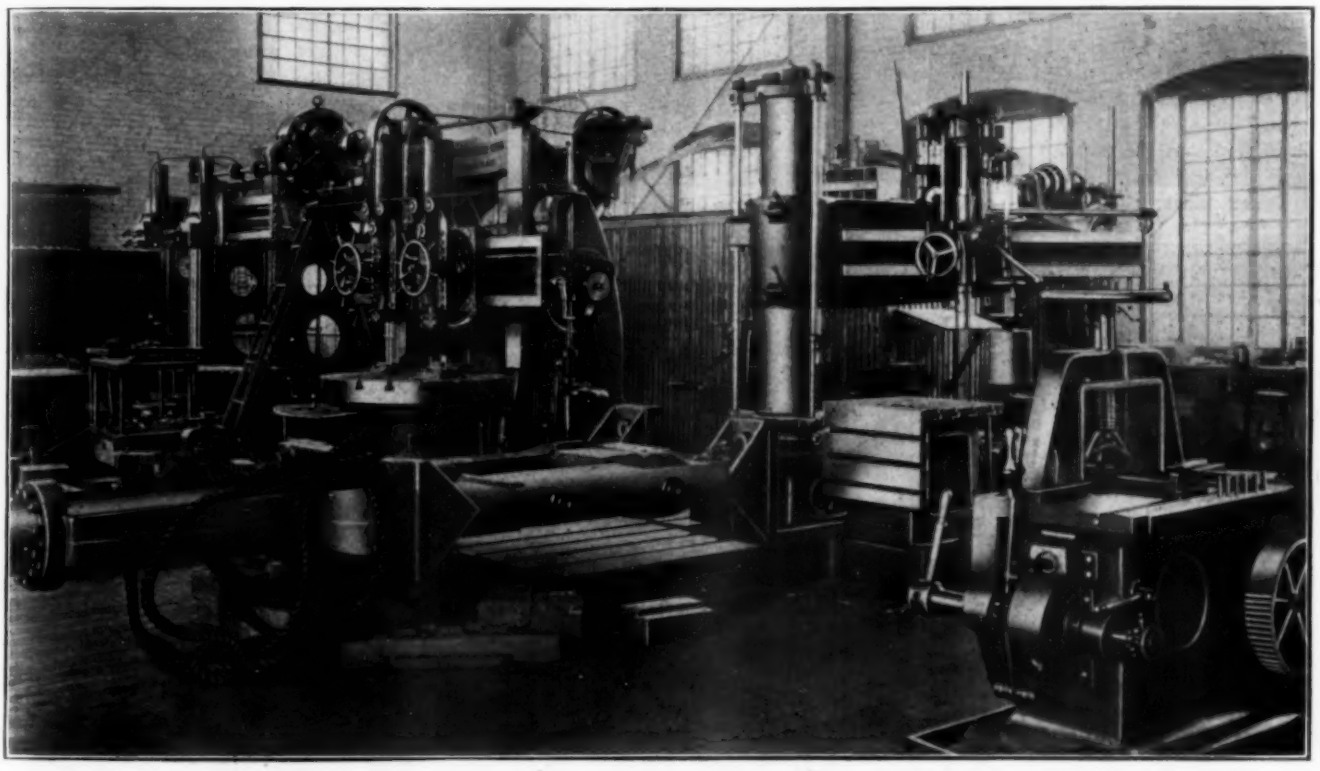


FIG. 1. A CORNER OF THE MACHINE SHOP

Fig. 2 shows one line of hammers in the forging shop. This shop is of the same size as the machine shop, i.e., 55x100 feet in general dimensions. It is served by a 15-ton crane and has the same hight under the truss chords as the machine

shop. This gives an airy and pleasant room with ample facilities for the removal of heat and gases from the forging fires. The hammers range from 300 pounds to 6000 pounds for the weight of the head. The largest one in the illustration is the largest of the series. Between the hammers will be noticed the hot trimming presses and sprue cutters. All of the hammers are steam-operated drops, and the method of piping is well shown. One of the great difficulties in connection with the operation of steam drops is the injury to the piping from the vibration and shock of the hammer. This point is cared for by the large bends which can be seen in connection with each one of the hammers illustrated. The steam mains are underground and the long risers, together with this loop at the top, form a method of piping which is giving good results.

There has been considerable discussion and controversy as to the best type of foundation for heavy drop hammers. Some advocate an all-concrete foundation made as solid and rigid as possible. Other authorities claim that an elastic foundation is necessary, which is usually formed by the introducing of wooden blocking. The foundation for this 6000-pound hammer is 27 feet deep below the bottom of the anvil block. The lower 12 feet of this 27 is a solid mass of concrete. On top of this is 3 feet of timber made from 12x12-inch hard-pine sticks laid horizontally and with the adjacent layers placed in opposite directions. On top of this is a block, somewhat larger than the base of the anvil, composed of 12x12-inch hard-pine timbers 12 feet long, placed on end

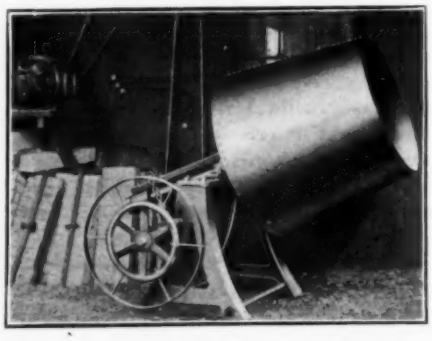


FIG. 3. A TUMBLING BARREL FOR CLEANING FORGINGS

and fastened by rods into a solid mass. The upper end of this block is shaped to receive the bottom of the anvil. Thus it will be seen that there is considerable elasticity in the foundation of this hammer.

The trimming presses are all driven by individual motors, which are mounted upon the frames as shown. An interesting feature of this drive is the small intermediate shaft carrying on one end a pulley which is belted from the motor pulley and on the other end a small pinion meshing with the gear on the driving-pinion shaft. At first glance this small shaft and pinion look out of proportion with the gear drive of the machine. But when the difference in speed is taken into consideration it is not found to be disproportioned.

The fuel used in the heating furnaces is natural gas, blown with low-pressure air at a pressure of about four ounces. This fuel is also used in the large case-hardening and heating furnaces for hardening the dies. Each hammer is provided with air under 10 pounds pressure for blowing scale from the dies, and this same air system is applied to all of the machine tools and is used for blowing chips from the work. In most cases this is arranged so that the air is constantly blowing upon the work; thus the workman does not have to resort to the use of a bench brush, or even turn on or turn off the air supply.

The usual method employed in cleaning drop forgings, that is, in removing the scale, is by pickling. Fig. 3 shows some-

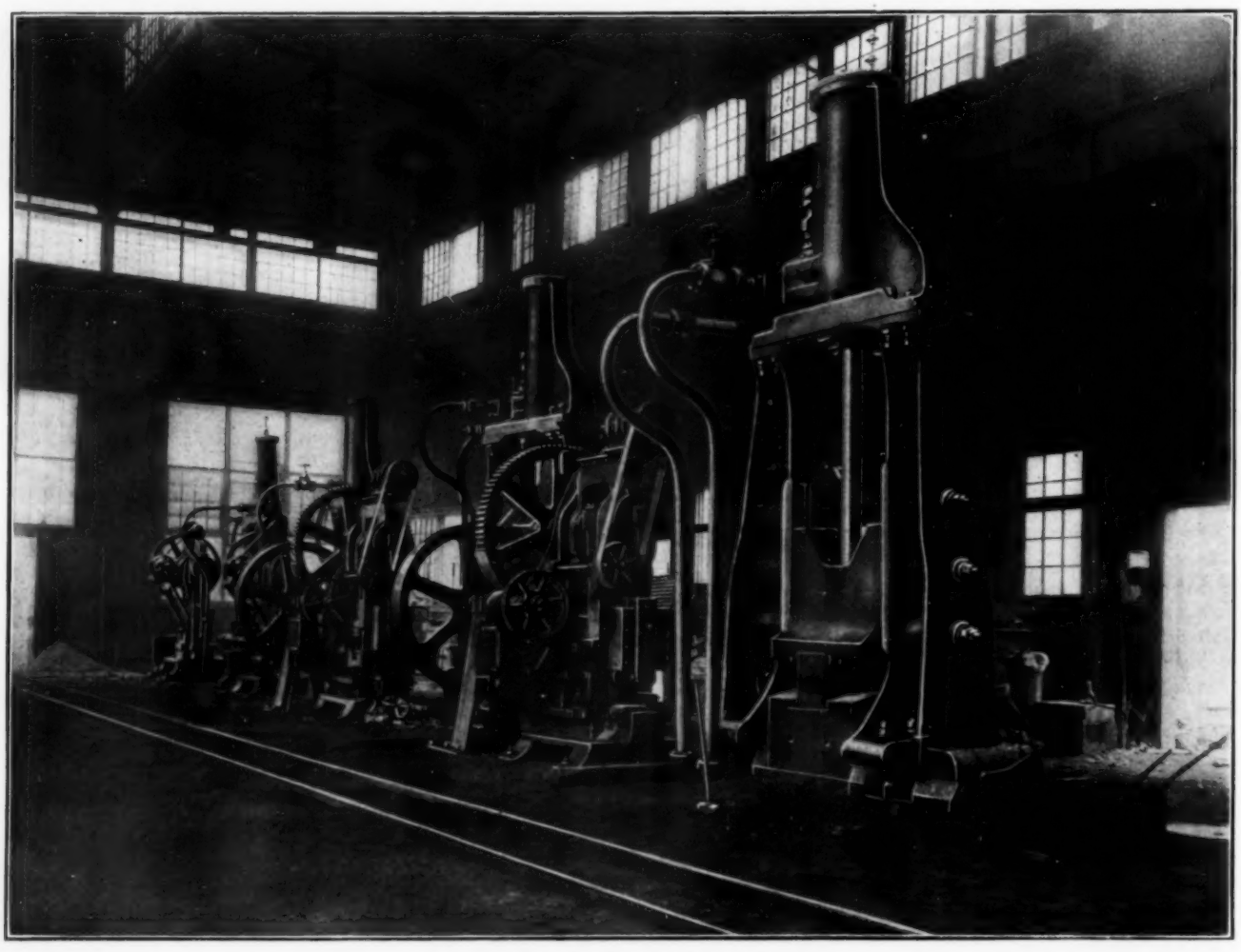


FIG. 2. A LINE OF STEAM DROP HAMMERS

thing of an innovation in this line, in the use of a tumbling barrel in place of the pickling operation. The advantage of this tumbling barrel in connection with forging work is as great as in connection with castings. While of course there are many kinds of small, delicate forgings which would be sprung or injured by tumbling, there are many which can go through the process without damage, and for such cases the cost of cleaning is reduced to a minimum. It is somewhat surprising that this method is not used more extensively in the drop-forging industry.

A truck load of dies is shown by Fig. 4. The largest set, that in the lower row at the right hand, is for the bent lever which can be seen in the upper central part of Fig. 5. This piece is first formed with the arm and shank parallel. It is then trimmed, the arm is bent or spread away from the shank and the set of dies which we have mentioned is used in finishing.

The two upper left-hand blocks shown in Fig. 4 are a hot trimming punch and die. At the extreme right in the upper row is one-half of the forging die for the same piece. Unfortunately this piece is not shown on the board of sample forgings in Fig. 5.

Turning again to Fig. 5, we see a number of drop forgings indicating the range of work which this plant produces. On the left are an automobile crank and an automobile front axle. They are the two largest pieces shown. Describing the

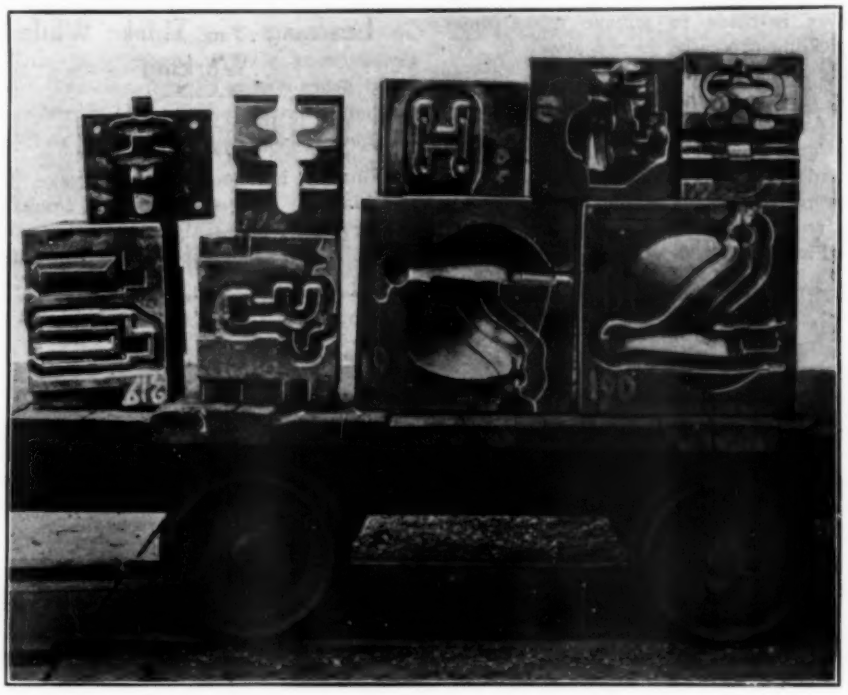


FIG. 4. A FEW DROP-FORGING DIES

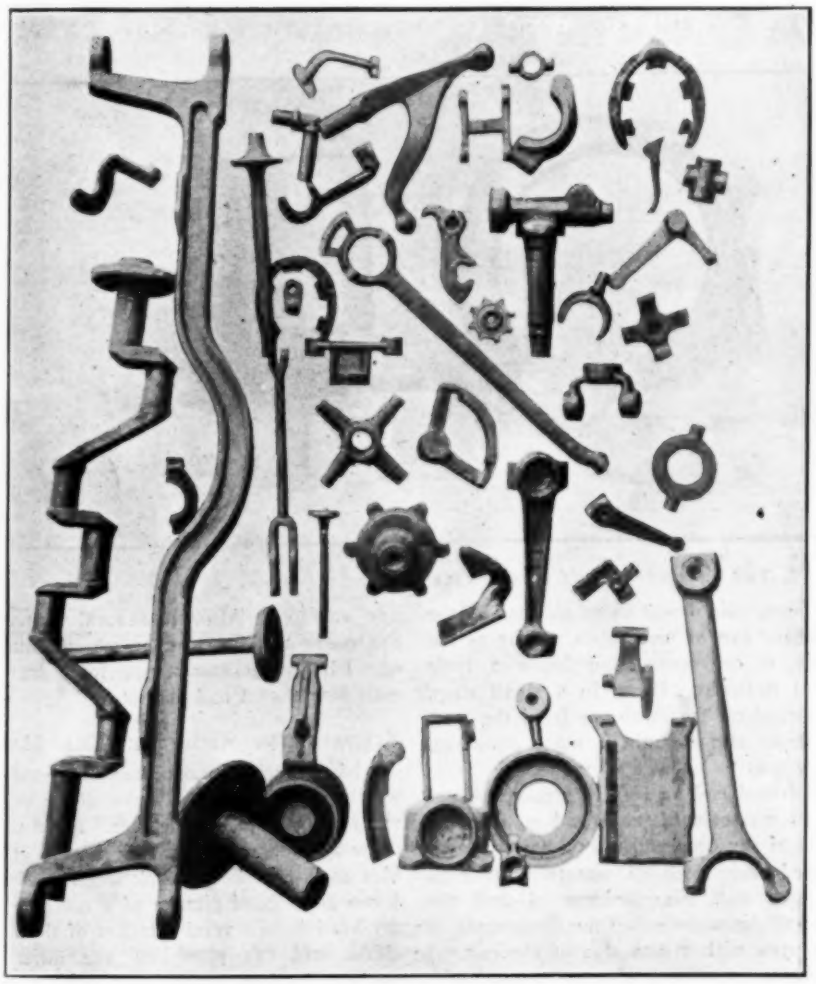


FIG. 5. SOME DROP FORGINGS

range of work in another way, it varies from forgings which weigh 80 to the pound to others which weigh 60 pounds apiece.

The die blocks which are used are mainly of open-hearth or crucible steel of a medium degree of carbon. They are hardened in fresh water, and, as is usual, are left with a soft back. In answer to a question in regard to the use of pneumatic chipping hammers in die sinking, we were told that they had been tried but had been found unsuccessful. They were capable of producing the work quickly and cheaply, but the vibrations of the hammer were such that they would shake the nerve of the die sinkers and render them incapable of doing fine and accurate work on the finishing operations. For this reason, although they showed some interesting results, they had to be abandoned.

All kinds of steel are forged, including some of the more expensive alloys. A large number of automobile valves have been forged from an alloy containing 35 per cent. of nickel. Several styles of these valve forgings are shown in Fig. 5. One is in the lower half of the illustration and directly behind the automobile crank shaft and axle. Another is in the upper part of the illustration and just at the right of the upper end of the axle. This alloy is very difficult to work. It is tough and tenacious and, even when heated to a proper forging temperature, it tends to bend and distort on the outside of the section when hammered, instead of forging and shaping throughout the mass of the bar. For this reason it

has to be handled very carefully and there is great liability of hammering particles of scale into the finished forging and of producing cold shuts. The forging scale is extremely hard and no attempt whatever is made to remove it. Ordinary pickling processes do not attack it. It is the common practice to ship these forgings as they leave the hammer.

Another interesting feature of this drop-forging work is that many forgings are made to gages. These are usually in the nature of limit gages and oftentimes have narrow margins of variation.

Figs. 6 and 7 show a new universal joint which has recently been developed by this company for the automobile trade. The two principal parts are drop forgings. It is shown partially disassembled in Fig. 6 and entirely so in Fig. 7. Referring to Fig. 6, it will be seen to consist of two drop-forged sleeves, which are alike, and from each of which project two pins which carry hardened-steel blocks. Each block is approximately a quadrant of a circle; thus when the two sleeves are fitted together, these blocks form a complete circle and form the driving points of the joint. The sleeves and blocks are held together by means of the collar and spanner nut which are shown in both Figs. 6 and 7. Fig. 7 shows all of the parts disassembled, from which it will be seen that they are extremely simple in design and construction.

L. P. A.

Learning to Think While Working

By B. H. Wood

Entropy is about right on page 305 in his idea of making anyone think in order to get any real benefit from work done. I have had experience in that line lately myself. I was about as good as the ordinary run of machinists, as far as the trade is concerned, and knew a little about drawing. Being in a small shop, I worked on the machines from the start to finish and thought I knew about all there was to know.

A friend had an idea of a machine and asked me to build it. I had no machine tools of my own and only what money I earned each week. I was to furnish all patterns and the machine. I had the over-all dimensions and the dimensions of one part, with a dim idea of the rest. I thought that it was easy and would take only a couple of months.

It is a good-sized machine, and after six months' work, I have about two-thirds of it done. I have had more actual experience in the last six months than I believe I had in the six years before that. As I could not see the whole machine in my mind and plan accordingly, I made one part, then made another to fit into place with the first. At times, parts that looked all right on paper were heavier than need be when I got the patterns or castings. I soon learned that 40 pounds of castings in a piece that would answer just as well if it had weighed but 20 pounds will eat quite a hole in the week's pay envelop. Also, if several patterns are made for the same piece, it counts up. I have a greater respect for a draftsman now than I had at first.

Sympathizing with the "Old Man"

I have received more than my money's worth in everything I have done, especially where I made mistakes. I can now draw a piece on paper and have a good idea as to how it will look when finished. I can get a good picture of a machine in my head from several sketches of the machine, and can plan how the different parts will come, something I had no idea of before. I know the cost of material, and

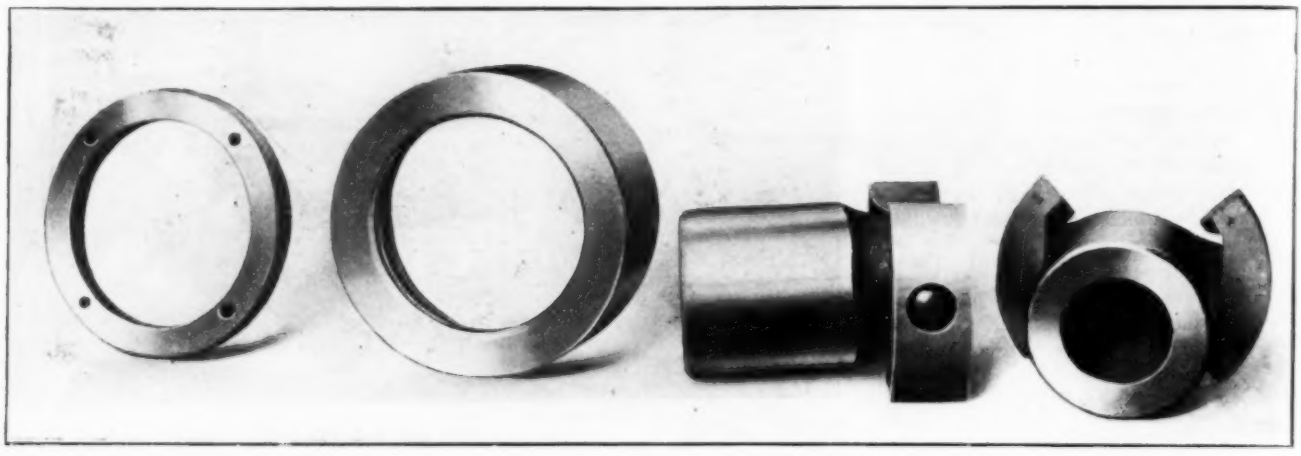


FIG. 6. A NEW UNIVERSAL JOINT

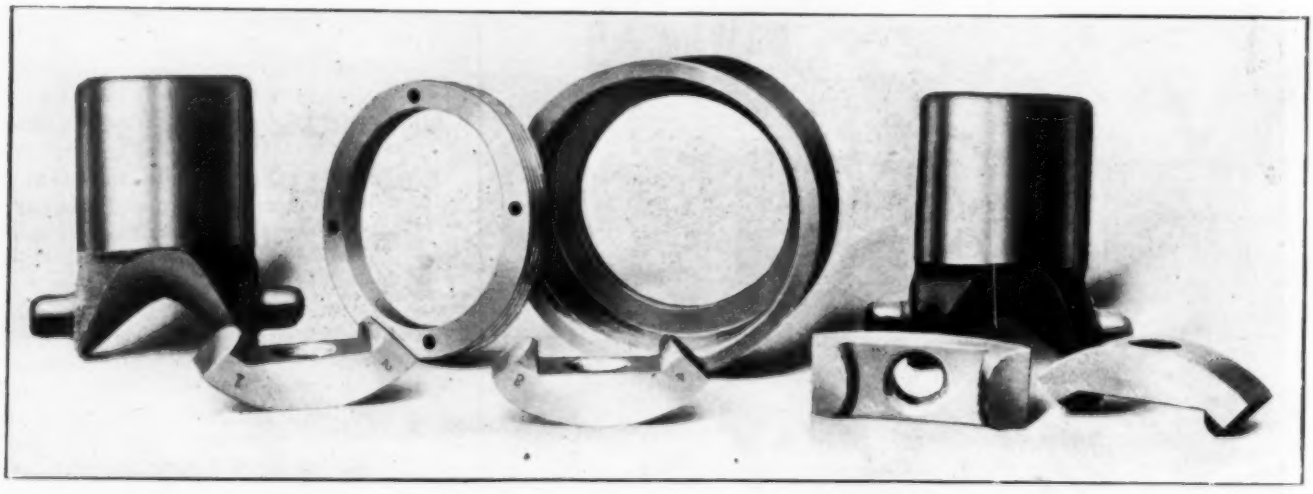


FIG. 7. THE UNIVERSAL JOINT DISASSEMBLED

can sympathize with the "old man" when a good-sized casting is spoiled. Before, I thought he was making a great racket about nothing, that he was stingy, that there were plenty more castings where that came from and it was nothing but iron. Above all, I think the new angle I have of looking at the boss' side is of most value to me. In material things I have a number of drills, reamers, arbors, etc., that will work into that shop that we all wish to own.

I believe that an experience like that is the best thing any young mechanic who wants to get up in the trade can have. Take a cut of some machine that you are not acquainted with, get several views of it if you can, and start to build one of those machines. It will give you ideas that you never had the least thought of before. The experience will be worth more to you than all the money you spend. It will also be worth money to the boss, which in the end will come back to you in better pay. You may lose a few of your good times, but you will have some idea of what the boss is up against. You may have an experience such as I had the week before July 4. I paid for two patterns and then ordered some steel for shafts. As I had no idea as to the cost, it took about all my money, and I had just 65 cents for the holiday, which will strike some of the young fellows where they would, not like to be.

I have seen young fellows, and some that were only near young, come into the shop and spend all their time looking at the clock and trying to kill as much time as possible on the job. If they could be made to do some such work as this, it would wake them up, or else they were intended for third-rate mechanics and always will be such.

All this may be an old story with many of your readers, but it certainly was a surprise to me in the good I received from the work.

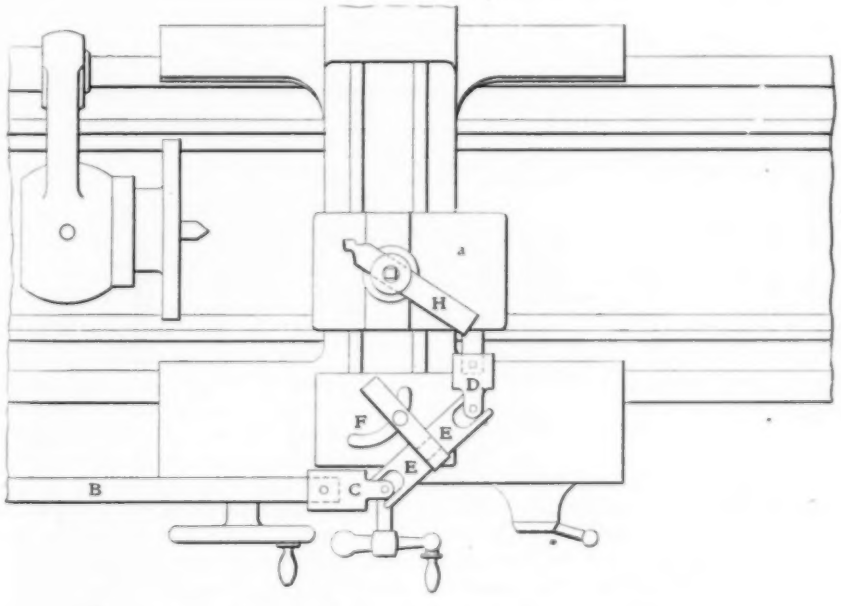
[We believe Mr. Wood is right in saying that he has learned more of the "boss' side" than he ever knew before and, knowing this, he is in a much better position to be a foreman, a superintendent or to run a shop of his own. He has had a practical object lesson that paid.—EDITOR.]

A Special Relieving Attachment

BY ETHAN VIALL

Our Pratt & Whitney and Hendy-Norton lathes both have relieving attachments suitable for taps, chasers, milling cutters and the like, where the lines of relief are practically parallel with the cross slide; but many of our special reamers used in brass-valve work we have to have relieved at right angles to this or at some angle between.

Hand relief with a file is both inaccurate and slow, so the special attachment shown in the sketch was designed, as we were unable to find anything in the market suitable to our needs. With this device in addition to the regular relieving attachment, relief at any angle, with the cross slide, between zero and 90 degrees may be obtained.



ANGLE ATTACHMENT TO REGULAR BACKING-OFF DEVICE

In Fig. 1 *A* is the regular tool post and slide furnished with the Hendy-Norton lathe for relieving purposes, and as anyone familiar with it knows, it may be swung around similar to an ordinary compound rest. Originally the parts represented by *A* were at right angles to what is shown; the half of universal joint *D* was connected to *C* and through the rod *B* connected to cam and gearing at the left end of the lathe.

Our device consists of an addition to this swivel joint, as shown in the sketch, and is shown in detail in Figs. 2 and 3. When wanted for use, this additional joint is slipped on the cross slide and coupled up as shown.

The piece *G'*, which holds the additional joint, is held in place by the tightening of bolt *L* and nothing else. When bolt *L* is loose, *G* may be turned or slid along the curved groove to whatever position is desired. The whole thing may be moved on the ways and clamped in the position wanted by means of the screws *M M*.

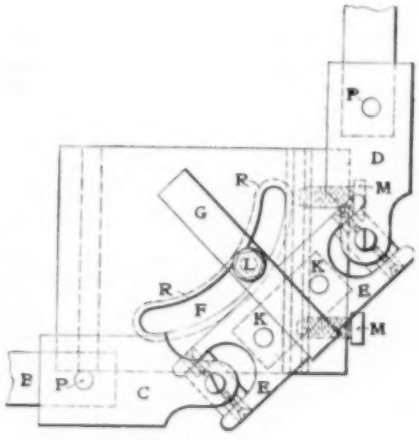


FIG. 2

FIG. 3

DETAILS OF THE COUPLING AND THE WORK DONE

The extra parts of the joint *E E* are held together by means of the short bar *K K*, which is carefully fitted to *G*, Fig. 2, and pinned to *K K* with taper pins. This bearing is perfectly satisfactory, as the joint does not revolve but simply moves back and forth in a very small arc.

Fig. 3 shows a sample of the relief done with this attachment. Ordinarily only relief *b* could be done, that is, straight away from the edge and in line with the cross slide, but with our additional joint, relief at *A* and *b* may both be done at once by setting the tool slide at the proper angle; or only relief *A* may be cut, by setting the slide at right angles, as shown in Fig. 1. This device makes the attachment absolutely universal, and any relief inside or out may be obtained with it.

The bar which connects *D* and the slide *A*, Fig. 1, is made with a keyway which allows it to slide out and in and so does not interfere with the use of the regular cross feed or the taper attachment.

The bar *B* is made in the same way and allows the carriage to be moved along the bed.

A Set of Dies for Field-coil Punchings for Wattmeters

By Julius F. A. Vogt

I recently had occasion to design a set of dies for field-coil punchings. The punchings had to be perfectly symmetrical, so that when they were reversed there would be no difference in the location of the holes or in the outline of the blank.

Fig. 1 shows the finished piece, and other sketches show the dies which produced the piece. A correct templet for the outline of the blank was made first. We were then ready to proceed with the blanking die, Fig. 2. The lower die was a wrought-iron plate, with a tool-steel ring welded on to it. After top and bottom had been machined, the templet was marked off on the die and the four corners were drilled and reamed to 1-degree taper from the bottom to within 0.005 of its size. Then the die was strapped to the face-plate of the lathe and the circular parts *A* and *B* were bored out to nearly its size. The two straight sides were then shaped out and the die was annealed, to relieve it of all strain. After this the templet was fitted through the die in every direction, to secure perfect uniformity of outline, and then the die was hardened and the temper drawn. When the templet was tried, it fitted nicely.

The punch was made of the same material, a steel ring welded to wrought iron. The punch was fitted to the die and the inside edge chamfered out about 2 degrees, to facilitate sharpening. There was no shearing given to either die or punch.

We were now ready to make the third-operation die for punching the four small holes and the two large ones. The die for this operation is shown in Fig. 3.

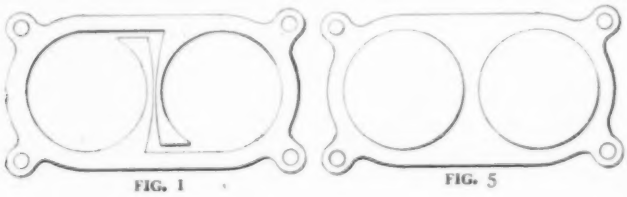


FIG. 1

FIG. 5

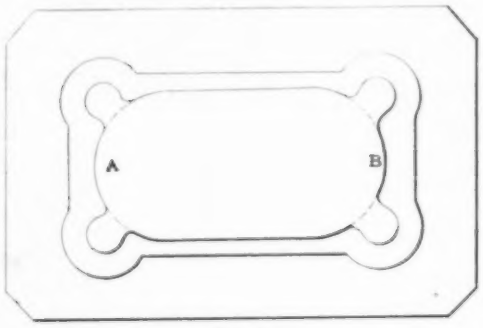


FIG. 2

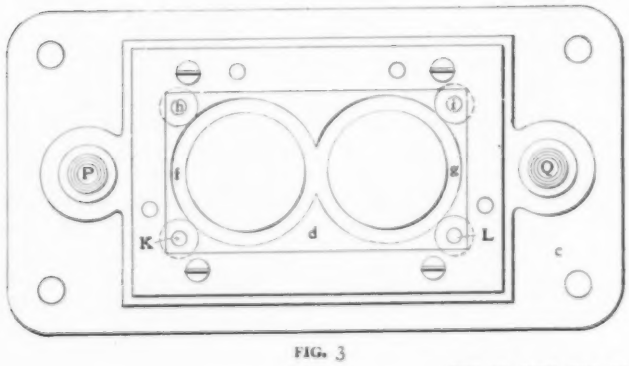


FIG. 3

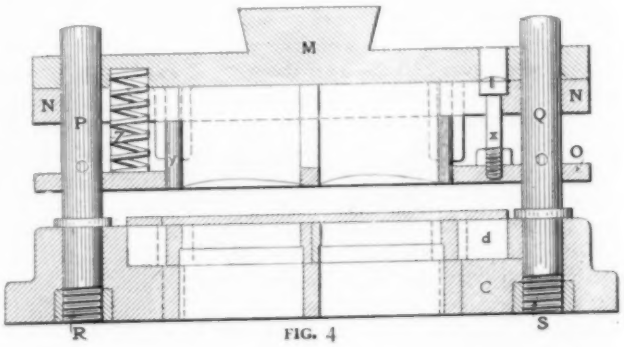


FIG. 4

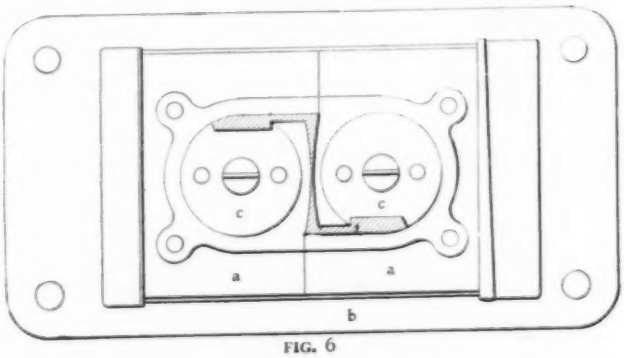


FIG. 6

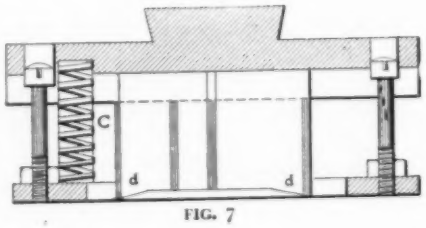


FIG. 7

SET OF DIES FOR FIELD-COIL PUNCHINGS

The lower die, Fig. 3, consists of the cast-iron die bed *C*, onto which the machine-steel block *d*, containing the two cutting rings *f* and *g*, and the four bushings, *h*, *i*, *k*, *l*, is fastened by means of screws and dowel pins. As will be seen by the sketch, the large cutting rings and the small bushings are shown ½ degree taper toward the outside bottom edge. The holes in the machine-steel block *d* are bored taper to correspond with the taper of the cutting rings and bushings; when the bushings are bored into it, and block *d* is fastened to the die bed, it makes a good fastening, at least I have found it so on this class of work, where light cutting rings are used for stock 1/16 inch thick.

The punch was made as shown in Fig. 4. The upper member *M* shows a dovetailed punch holder fitted with a pad *N* and held together by four taper-head screws and two dowel pins (not shown).

Through the pad *N* and the stripper *O* two holes were drilled, and two pins driven to hold both together. The pad and stripper were now clamped to the lower die, and both large holes marked. Pad and stripper were then strapped to the face-plate of the lathe and bored out to receive the punches, as shown in Fig. 4, the stripper being bored just a trifle larger to give the punches a sliding fit. The punches were then driven into the pad, and the pad, with the stripper, clamped to the lower die. The two holes for the guide posts *P* and *Q* were drilled and screwed through punch holder, pad, stripper and die bed. The die bed was then counterbored on the bottom for the nuts *R* and *S*. The guide posts were now inserted, and the four small punches located; then the punch sockets *T*, *U* were put into the pad and the small punches were fitted.

We left the fitting of the four small punches purposely after the guide posts

were set, as I found from former experience that it was best to do so. The screws *Y*, *X* and the holes for the springs *Z* were then drilled and the punch was assembled. The springs were not intended to strip the work from the punch; they were merely to hold flat down in the gage the blank to be punched. I find it a good plan to hold the blank flat, with either steel or rubber springs, if the press is not provided with a cam action for the stripper.

To secure positive stripping a 3/8-inch hole was drilled through each guide post, as shown in Fig. 4, for the stripper to strike against when the ram of the press came to the highest position of the stroke. This press had 1-inch stroke. Fig. 5 shows the work done by this die. The third-operation die and punch, for cutting the Z opening between the two round holes, is shown in plan in Fig. 6, and in elevation in Fig. 7.

The lower die, Fig. 6, is made in two parts *a a* to save work. These two parts were keyed into the die bed *b*. The two round gages *c c* located in proper relation to the two round holes punched in the previous operation, are fastened by two flat-head screws, and four dowel pins. Screws and dowels go through the die into the bed plate to prevent any chance of shifting of part *a* from front to back. The cutting punch was made as shown in Fig. 7, the upper part of the punch being provided with three flat prongs, corresponding with three holes in the pad. The punch was hardened at the cutting edge, with the prongs left soft and riveted into the pad.

The cutting parts of the forming punch, marked *d d*, were left 1/4 inch longer, to enter the die first, forming a guide for the rest of the punch. The stripper was bored out to fit nicely over the gages *c c*, and was then worked out to a sliding fit over the cutting punch. The screws for holding the stripper in position and the spring holes were drilled, and the punch assembled. The stripping of the work was done by four springs *c*, as in this case there was no hard stripping to be done. This operation finished the blank as shown in Fig. 1, and made it perfectly reversible.

Turning a Large Disk in a Small Lathe

By Frank B. Davant

Not long since, an order was received by the plant where I was superintendent for a number of cast-iron disks 13 feet in diameter, with a large hole in the center and weighing about 25,000 pounds. These disks were to be used as rubbing beds for finishing marble slabs, building blocks, etc., and had to be faced perfectly smooth and to a plane surface on one side.

The company did not have a boring mill large enough for the job, and the largest lathe in the shop was an antiquated affair of very light construction, with triple gears, swinging 60 inches above the bed. This machine was the only one available for the purpose, and as it was frequently used for other work its adaptation to the job in hand had to be made in such a manner as not to prevent a quick change from the disks to any hurried job that might come in.

The main spindle extended several inches through the outside bearing to receive the third gear, and had a two-inch hole through its center. This gear was removed, but no other part of the machine disturbed, and in its place a seven-foot face plate was firmly keyed to the spindle. On the back of the face plate a spur gear was cast corresponding to the one taken from the spindle, with the space between the hub and the gear heavily ribbed to stiffen the plate. Six heavy lugs *a* Figs. 1 and 2, were cast on the face, equally spaced and concentric with the center, and tapped for set-screws. These screws were used for centering the disk by having their points bear against the wall of the hole. Slots and holes were also cast in the plate for bolting the disk to the plate.

A heavy flange *b* was made with its diameter six inches greater than the hole in the disk. Into this flange was pressed a five-inch steel shaft, the ends projecting through the flange and the shorter one turned to fit the hole in the lathe spindle. The outside face of the flange was then faced back half an inch and to a diameter somewhat greater than the disk hole, and six holes, corresponding with those in the face plate, were drilled for bolts. A rigid pedestal *d* was firmly anchored to a concrete foundation 30 inches from the face plate, and babbitted in perfect line with the lathe spindle. This was to receive the flange shaft, as shown in Fig. 1.

Four I-beams were firmly riveted together and bolted to a concrete foundation, upon which was superimposed the cross rail from a discarded planer. This carried the tool post *e*. The tool was fed by a ratchet attachment on the screw. A suitable reduction of the spindle speed completed the rigging and the machine was ready to proceed with the work.

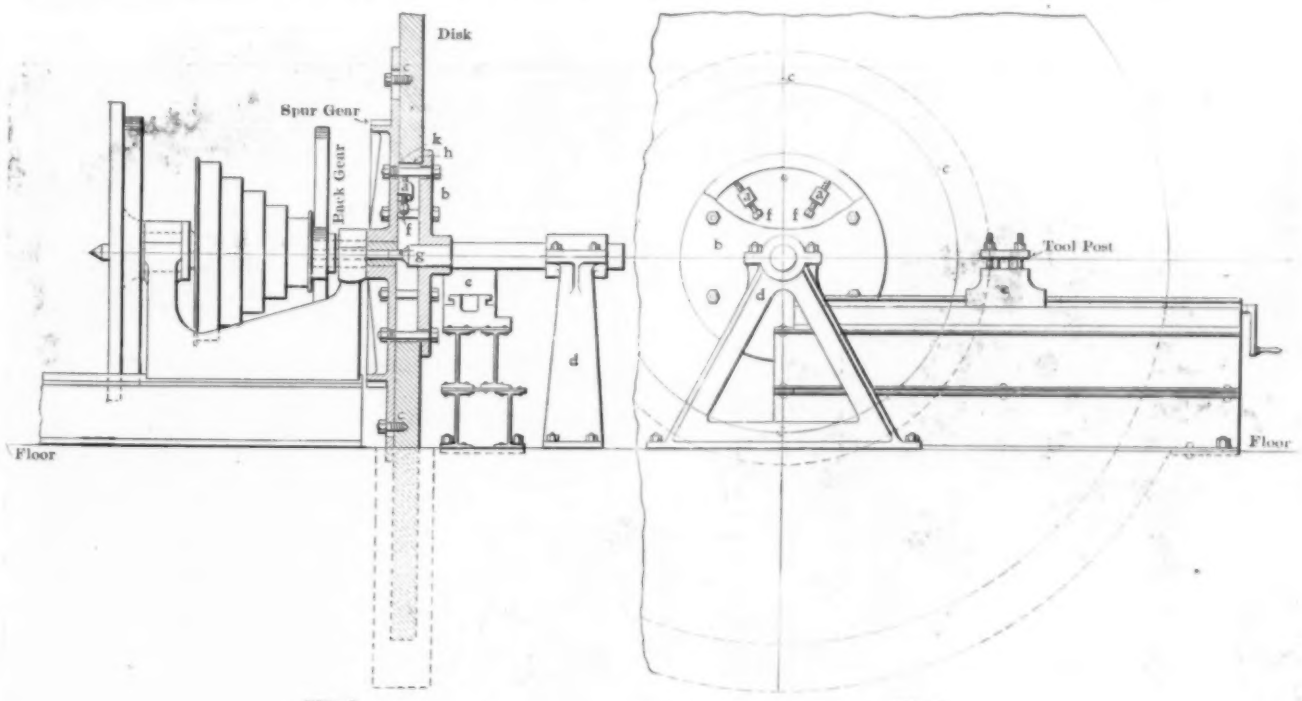


FIG. 1 FIG. 2

TURNING RIG FOR A LARGE DISK

A disk was drilled, tapped and bolted to the face plate as shown at *c*, and trued by the screws *f*. The hole was then bored back a short distance, the disk faced to the proper thickness, six inches away from the hole. The flange was then put into position as shown and securely bolted to the face plate and a cut started. It can readily be seen that this arrangement is very rigid, doing away almost entirely with the vibration of the disk and the inevitable breaking of the spindle.

The pinion on the back gear shaft engages the gear on the face plate, imparting a smooth steady motion. The bearing at each end of the flange shaft, together with the firm clamping of the flange, disk and face plate at *h* and *k*, relieves the lathe spindle of all strains save that due to the dead weight, and insures freedom from tool chattering.

A large number of these disks, ranging from 20,000 to 25,000 pounds each, have been faced and turned in this lathe with excellent finish and satisfactory speed.

Had the headstock been reversed and the small face plate replaced with the large one, even more satisfactory results could have been attained, but this was precluded by the fact that there was not another machine in the shop to take care of the work.

Turning a Rudder Stock in a Lathe Too Small to Swing the Rudder

By H. A. Evans

An urgent dock-repair job at the Mare Island navy yard required the turning of a rudder stock, for which work there was no lathe that would swing the rudder. The turning was accomplished as follows: A 6-inch Saunders pipe machine was put on the ways of a 63-inch motor-driven lathe, with its center in line with the lathe center. The rudder stock was clamped in position on the lathe carriage. A collar was inserted in the hollow spindle of the pipe machine to guide the stock and keep it central. The turning was expeditiously carried out with this rig, a section 6 feet in length and 5½ inches in diameter being turned in six hours. The half-tone illustrations Figs. 1 and 2 clearly show the arrangement of the lathe, pipe machine and work, with the method of driving and the cutting tools.

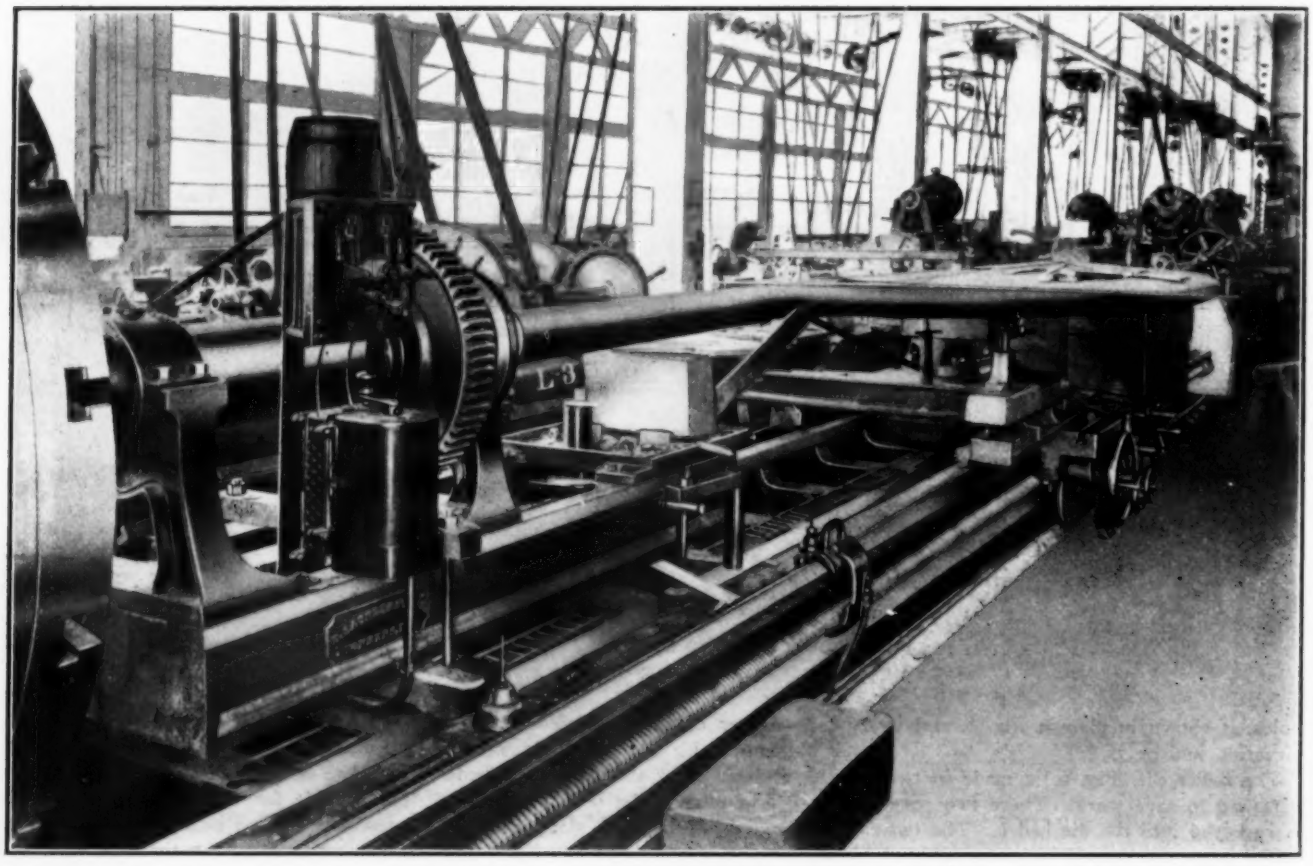


FIG. 1. THE RUDDER STRAPPED IN POSITION ON THE LATHE

Cheap Fuel in Irkutsk

Consul Paul Nash, of Vladivostok, makes the report that the wholesale price of coal in Irkutsk varies from $3 to $3.45 per ton of 2000 pounds, while the retail price is 1 kopeck per pood, or 28 cents per ton, more. All the coal used comes from 11 mines not distant from Irkutsk, most of which are situated on or near the line of the Trans-Siberian Railway. The quality of these coals is said to be uniform, or nearly so, and fairly satisfactory for steam and domestic purposes. The prices of firewood vary considerably, according to the season and the cost of transportation, and are generally very low. Owing to the cheapness of coal, briquets are not used at all.

Making Tubes by the Extrusion or "Squirting" Process

Editorial Correspondence

We are so apt to think of metals as being solids and incapable of being materially changed in form without heating or hammering that we overlook the fact that they are made up of particles which can flow cold and change position quite readily if enough pressure is brought to bear on them. The squirting of metals is not new and bars of extruded stock are being produced for various purposes, for much the same line of work that cold-drawn stock is used—where it is desired to get a dense stock with corners sharp or to a special shape.

But when it comes to taking copper and treating it much as you would putty, it is a little startling at first sight. Yet this is practically what the Lee process amounts to as will be seen.

In Fig. 1 is shown a section of a die with a soft copper disk lying in the bottom. Above it is the punch with a short projection, this projection being enough smaller than the hole through the bottom of the die to allow for thickness of the walls of the tube. The entrance to the hole is slightly rounded and there is a corresponding fillet on the projection of the punch.

The punch is forced down by a powerful press, the projection first forcing the center of the disk into the bottom hole and then the pressure of the punch comes on the whole surface of the disk. The pressure then slowly forces the metal in the disk out of the only opening through which it can escape, which is around the projection and between that and the walls of the die. Continued pressure forces all of the metal through the die and the length of tube that is produced depends on the amount of metal in the disk and the diameter and thickness of the tube as regulated by the die and the punch.

Fig. 2 shows the tube partly formed, with the end closed by the central portion of the disk which was forced through the die first. For making a tube without this the disk is punched with the right size hole at the same time it is blanked out.

If the tube is wanted with a wall which is thicker at one end than the other, the projection on the punch is made with taper as shown in Fig. 3. The effect is to produce a tube something as shown in this figure.

At first glance it is not clear just how this produces the desired effect with such a short taper on the projection. But it must be remembered that the punch moves a very short distance, just the thickness of the blank, in making the tube, say a foot long. So that the taper of the projection is distributed over the whole length of the tube and can be regulated as desired by considering the angle of the punch, the thickness of the blank and the length of the tube.

By this method almost any shaped tubes can be made as easily as round and tubes are now being made of a special section for automobile radiators.

Any of the softer metals or alloys such as copper, brass, zinc, tin or aluminum can be worked in this way and the strange thing is that zinc responds as easily as aluminum, which gives this process the lead in making zinc pipe for brewery and similar use, the usual process being very expensive on account of the nature of the metal. In view of this it is rather surprising that zinc can be handled in this way as it would seem to be suited to only the most ductile of metals.

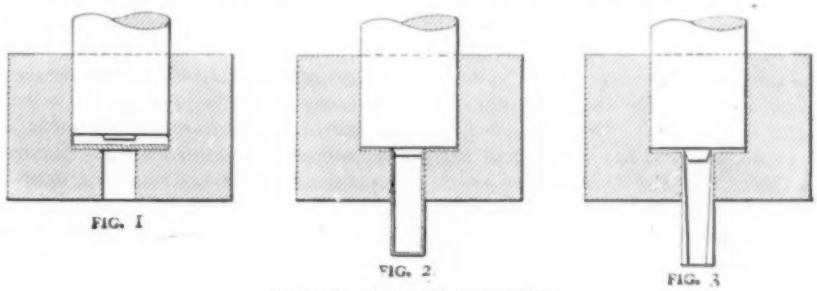


FIG. 1 FIG. 2 FIG. 3

MAKING TUBES BY EXTRUSION

While the main product of this process will probably be tubing of special shapes and sizes, it is also used in making blanks for thumb screws and many similar pieces. In this case the punch would have no projection so that a solid stem of metal would be forced through the die for the threaded portion of the thumb screw, while the head would remain inside.

Many experiments have been made along this line by the developers of this process and it is only by the use of high-

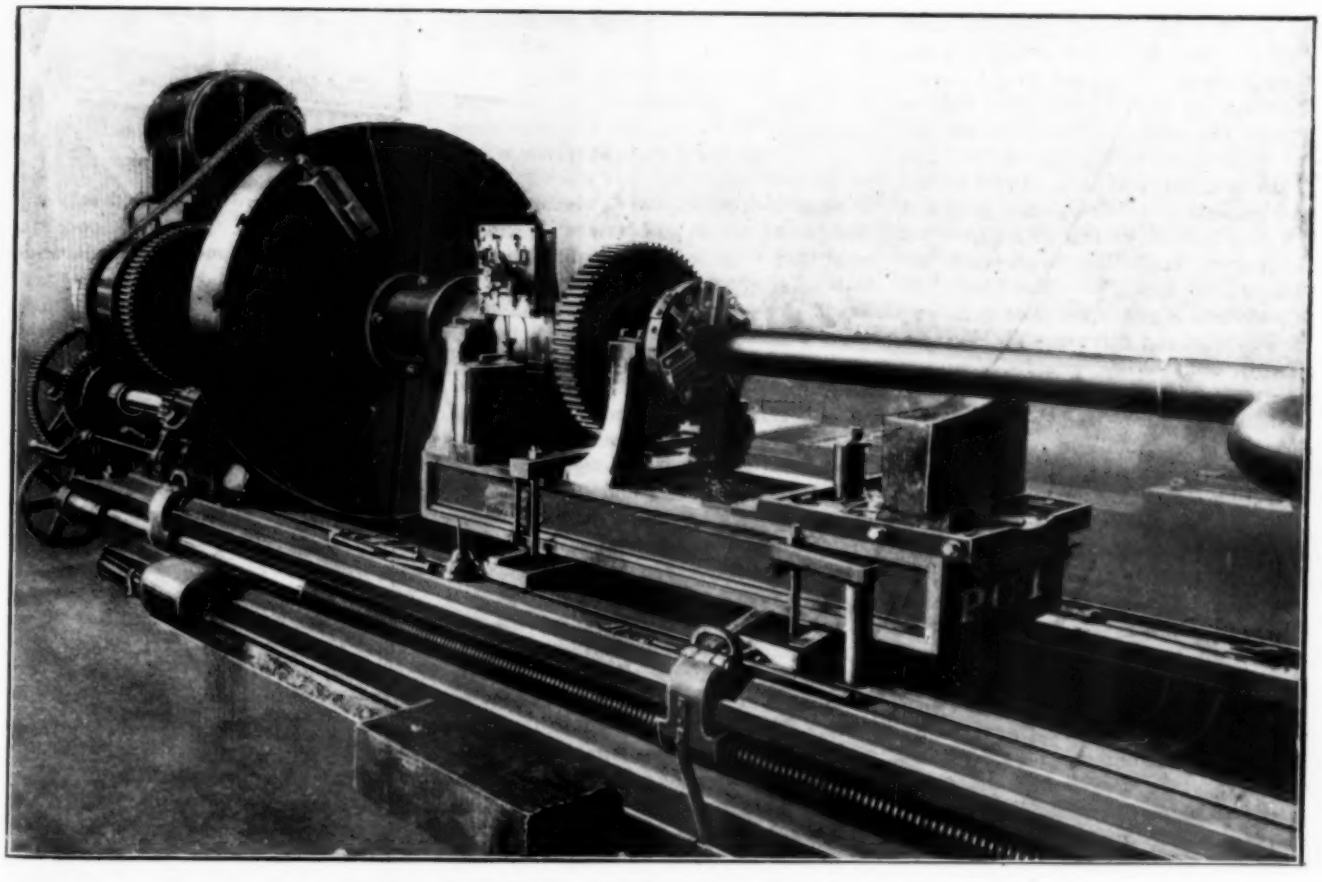


FIG. 2. THE PIPE MACHINE AND CUTTING TOOLS AT WORK ON THE RUDDER STOCK

speed steel that copper can be worked successfully; carbon-steel dies will not stand the immense pressure necessary for this work.

Were it not for this it is believed that iron and steel could be extruded in the same way, but copper and brass seem to be about the limit in the way of metals to be worked, limited by the pressure the dies will stand.

There are other uses for this process which are now being developed and which will be made public later. The work is being carried on by the Metallic Shell and Tube Company, Pawtucket, R. I., to whom we are indebted for the facts and for samples of the work. One of these tubes has a solid end and has walls about 0.004 inch thick. That the ductility was not destroyed is shown by the end being readily flanged down without cracking. While the movement of the punch is very slow, the metal forming the tube comes out of the die at the rate of about 5 feet a minute and in spite of this it does not warm the metal as much as might be supposed when the rather violent changes of its particles are considered. F. H. C.

Designing a Press Frame

By Con Wise

The replies to my article on the design of press frames from Messrs. Neely, Searle & Bradford, on pages 24 and 25, give three entirely different views of the problem for which I had already proposed three different solutions. Out of all this the average reader is not apt to get a very clear idea of what is right and what is wrong. The careful student, however, will find some truth in all the solutions and yet be in doubt if any are correct for the problem which was originally proposed.

I shall have to confess that I have not received as much help from these replies as I had hoped for. Yet I have kept digging into it and, with some little help from Slocum and Hancock's books on the strength of materials, would like to propose the following as likely to be of help in similar cases without being so involved as to be impracticable in every-day use.

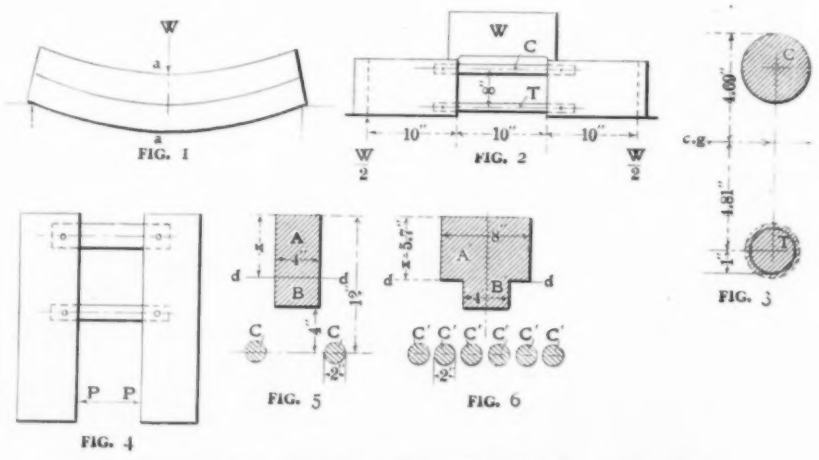
The first essential of the problem and of every problem in composite beams is to locate the neutral axis. For the sake of those who are not familiar with the theory of beams I will try to put it in more common terms. Fig. 1 represents a side view of a beam which is supported at the ends and loaded at the middle. If this is a steel beam and square in cross-section, if we draw a series of fine parallel lines on its side when it is straight, then after it is bent we will find that the top lines are shorter and the bottom lines are longer than at first. But in the middle there will be one line which will be just the same length as before. If we take any cross-section, as at *a a*, then a horizontal line drawn in this cross-section and meeting the line which is neither shortened nor lengthened will be the neutral axis of the section.

If we imagine a beam made of a material that cannot be compressed but which will readily stretch, then the neutral axis will be at the top of the beam; on the other hand, if the material cannot be stretched but is easily compressed, then the neutral axis will be at the bottom. If the material is equally compressible and extensible, then the neutral axis will pass through the center of the cross-section if it is symmetrical, and through the center of gravity of the cross-section if it is unsymmetrical. Since this condition is met by ordinary structural steel shapes, which are the most common material used for beams, it is not at all surprising that most people believe it to be true with all materials and all combinations of materials. This extensibility and compressibility is expressed by dividing the pull and push in a one-inch square bar by the stretch of that bar in one inch of length. It will be seen that there may be a difference in this ratio whether the stress is large or small. In steel this ratio remains the same over a large range. In cast iron it varies as the stress is changed. It varies more in tension than in compression and is rather unreliable anyway. This ratio of stress to stretch is known as the modulus of elasticity and is designated as *E*.

Every fiber in a beam under a transverse load may be considered to be under a stress proportional to the distance from the neutral axis. For example, suppose the bottom fiber of the beam in Fig. 1 to be under a tension of 1000 pounds per square inch. Then the one at one-half the distance from the bottom to the center is under a stress of 500 pounds per square inch. This is found by measuring the longitudinal lines above referred to and is true if the modulus of elasticity is constant; not otherwise. This is especially incorrect if the beam has been bent enough to be badly sprung. It is independent of the cross-section, whether it is irregular in shape or not, or whether it is all in one piece or not, so long as all parts are firmly held in their position in regard to each other.

Let us consider a beam solidly made of two different materials, as in Fig. 2, with a weight *W* straddling the horizontal bars *T* and *C*. Then *T* will probably be all in tension and *C* all in compression, and the two bars will act as a simple beam. The tension in *T* will be greatest on the bottom, and the compression will be the greatest on the top of *C*. This point was seemingly overlooked by Mr. Searle. If the two bars are to be the same size and of materials such that *E* for compression in *C* is the same as *E* for tension in *T*, then from symmetry the neutral axis is halfway between them. But if *E* for each is the same, then the neutral axis will be at the center of gravity of two circles held at the same distance apart as the two bars; if one bar is larger than the other, then the center of gravity will be nearer the large circle and the neutral axis will also be nearer to it. But if the two bars are not of the same modulus of elasticity, then in order to find the neutral axis, it is necessary to replace one of these circles by one whose *area* is proportionately larger or smaller, according as its modulus of elasticity is larger or smaller.

For example, suppose the bar *C* to be 3 inches in diameter and of cast iron whose *E* is 20,000,000 at the greatest safe stress. Suppose that the bar *T* is 2 inches in diameter and of steel whose *E* is 30,000,000 up to its elastic limit. Then to find the neutral axis of the section through the bars we first draw the actual cross-section, as in Fig. 3, and then either enlarge the area of the small circle or decrease the area of the largest circle in proportion to their moduli. In this case the dotted circle shows the small circle enlarged to one and one-half times its former area (1.22 times its diameter). Taking moments around either center, we find the center of gravity to be 4.81 inches from the center of the small circle. Looking at Fig. 3 again, we see that this brings



DIAGRAMS IN CONNECTION WITH THE DESIGNING OF A PRESS FRAME

the fiber in greatest tension in T 5.18 inches from the neutral axis. The one in C in the greatest compression is 4.69 inches from the neutral axis.

Having found a neutral axis, the next thing is to find the moment of inertia of the section. Now in order to determine what moment of inertia to use, whether that of the original section or that of the modified section, let us see what the moment of inertia of a section really is. If we take a plane surface and divide it into little areas, and multiply each area by the square of its distance from any given straight line in the plane of that area, and add all the results, we have what is known, for want of a better name, as the "moment of inertia." It might just as well be called the "diomatheticus" as any other name so far as the significance of the name is concerned. As a matter of fact it is usually designated by I, which answers all purposes. There is a different I for every line which we may use for an axis. The one that we used is taken about the neutral axis of the modified section, and consequently it is the I for the modified section that we want. In this case I is about 184 biquadratic inches, that is, square inches multiplied by inches squared. The bending moment exerted on the beam is the same throughout the length of these bars and is equal to $\frac{W}{2} \times 10$.

If we assume that we wish to carry 80,000 pounds for W, then filling in the equation $M = \frac{p\,I}{l}$ we have:

$$\frac{80{,}000}{2} \cdot 10 = \frac{p\,184}{5.81},$$

and

$$p = 12{,}840 \text{ pounds.}$$

On the compression side

$$\frac{80{,}000}{2} \cdot 10 = \frac{p\,184}{4.69},$$

and

$$p = 10{,}200 \text{ pounds.}$$

But on the tension side all our computations have been on the basis of a modified section with one and one-half times the area which we actually have to resist the tension. Since it is the actual section that holds the stress and not the modified area, the actual stress will be a half larger than we have computed or 19,200 pounds, which will be rather large for anything where much harm may result from breakage. On the compression side 10,200 pounds is not a large pressure to put on cast iron, and as no modification was made in its area, so no allowance need be made.

Our problem is practically the same as this one except that we have the distributed tension due to the load, because the load is applied as in Fig. 4.

* * * * * * * * * * *

I had written thus far when the July 25 issue came in with the excellent article by Messrs. Duncan and Peam, on page 129. This rather takes the wind out of my sails in a way, and yet it seems as if it is due to the readers of the AMERICAN MACHINIST to state the reason for these various modifications. There are doubtless a great many who feel better satisfied to use a method if they know its whys and wherefores and its limitations. There are, however, some things in Messrs. Duncan and Peam's article that seem to me to be open to debate.

For example, in getting at the distribution of the direct tensile stress, they make assumptions which may or may not be true. The results reached reduce the compression at the back of the frame by 140 pounds per square inch and increase the tension on the bolts by 760 pounds per square inch as compared with my method of considering the direct tension

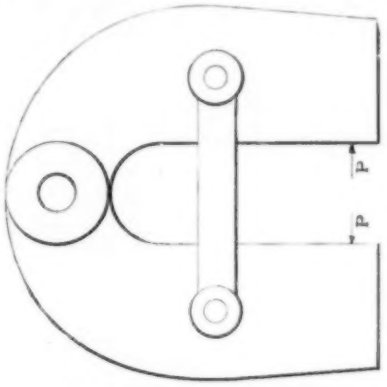


FIG. 7. A PIVOTED FRAME

as uniformly distributed over the section. This is within the amount which the material may be expected to vary between one press and another of the same pattern, so I should prefer to stick to the simple method.

In getting at the position of the neutral axis they assume that the modulus of elasticity for cast iron is the same both in tension and compression. This condition the discussion over cast-iron beams seemed pretty well to show could not be true. If the E for cast iron were the same in both tension and compression, then such beams would act exactly like steel beams of the same E, and there would be no chance for discussion. For purposes of illustration only, I am going to assume that E for steel in tension is 30,000,000, for cast iron in compression 20,000,000 and for cast iron in tension 10,000,000. I feel that it might be possible to get such a combination, though whether it could be predicted that any one frame would be made with just those values is at least doubtful.

Fig. 5 is our original cross-section, divided by the line $d\,d$ (the neutral axis) into part A which is cast iron under compression, part B which is cast iron under tension and part C which is steel under tension. As indicated by the dimension X, it is unknown just where this division will come.

Fig. 6 represents this section when transformed by Messrs. Duncan and Peam's method to a basis of a material having an E of 10,000,000.

A' is twice the area of A, since its E is 20,000,000.

B' is the same size as B; since its E is 10,000,000.

C' is three times the area of C, since its E is 30,000,000. The line $d\,d$ (the neutral axis) passes through the center of gravity of this modified section. Taking moments around $h\,h$, we have:

$$\frac{8x \cdot \frac{x}{2} + 4(8-x)\left(x + \frac{8-x}{2}\right) + 6\pi \cdot 12}{8x + 4(8-x) + 6\pi} = x.$$

Solving, $x = 5.7$ inches.

The I required will be the I for the modified section which we find by the same method as in the article on page 129 to be 1273.

In the present case:

M (external bending moment) $= 40{,}000 \times (12 + 2.3) = 572{,}000$ pounds.

$$Z_c = \frac{I}{y_c} = \frac{1273}{5.7} = 223.$$

$$Z_{t\,(\text{cast iron})} = \frac{I}{y_{t\,(\text{cast iron})}} = \frac{1273}{2.3} = 553.$$

$$Z_{t\,(\text{steel})} = \frac{I}{y_{t\,(\text{steel})}} = \frac{1273}{2.3 + 4 + 1} = 174.$$

Following Duncan and Peam's notation, we find that

$f_c = 2565$ pounds per square inch.

f_t (cast iron) $= 1034$ pounds per square inch.

f_t (steel) $= 3280$ pounds per square inch.

Now our modified section has twice the area of cast iron under compression that occurs in the actual frame; since it is the actual frame that has to carry the stress, it must sustain twice the stress which appears above, or 5130 pounds per square inch. The cast iron in tension has the same area as before; hence the actual stress is as above, 1034 pounds per square inch. The steel in tension has three times the stress computed above, or 9840 pounds per square inch. To all these must be added (algebraically) the uniform tension over the actual area $= \frac{40{,}000}{32 + 6.28} =$ 1040 pounds per square inch.

This gives us:

Compression in cast iron $= 5130 - 1040 = 4090$ pounds per square inch.

Tension in cast iron $= 1034 + 1040 = 2074$ pounds per square inch.

Tension in steel $= 9840 + 1040 = 10{,}880$ pounds per square inch.

All of which are safe for the sections and would be for a load nearly 50 per cent. larger.

Using the method of Mr. Neely, but modifying the section as above, I find that the depth of the cast iron at the throat can only be 5½ inches if the neutral axis

is to pass through the air space and thus put all the cast iron in compression. Carrying on the computations in the same way, I find that under a load of 40,000 pounds the maximum compressions in cast iron will be 5900 pounds per square inch and the maximum tension in the steel 16,400 pounds per square inch, which does not show as great an economy of material as the original design.

To get back to Mr. Neely's suggestions, I hope that he is convinced that the neutral axis of a beam is not tied up to the center of gravity of the actual section. To Mr. Searle I would say that if his press were built like Fig. 7, with the frame pivoted at the back and the bolts pivoted at the sides, his method would apply. If he can imagine his hammer head cemented firmly to the block on which it rests and the block cemented to the table and the nail cemented in place, I think he will see that the cement would affect his day's work at pulling nails. Here is another thing that Mr. Searle and I have ahead of us to thresh out: Is a piece of soft rubber just as good as a piece of steel to pry on when ripping open a box? How is it? Getting the air under tension in my first sketches was a mistake of course, but since it is perfectly elastic it will come back where it was before, all O. K.

Mr. Bradford's method I cannot fathom, though his point that a different condition is brought about by putting an initial tension on the bolts is well taken. Nevertheless, it does not seem to me, so obvious that it would not do to have the frame stressed as much when not in use as when in use. It is only under a safe stress, it is safe to hold it there a hundred years. It would be possible to put so great a tension on the bolts that the cast-iron part would be stressed just as much as when working without initial stress, but in the opposite way. Then, when the working load was put on it would relieve the frame of all stress and double the stress on the bolts, which would mean twice as large bolts as are necessary under ordinary conditions.

To sum up the case, however, the deeper down we get the muddier is the bottom. We have not touched on the effect of the curved outline referred to by Duncan and Peam, which is excellently discussed by Slocum and Hancock's book to which I have referred. One reason is that in the few cases where I have applied this method it has not made difference enough in the results to pay for the work, even although the graphical method there given is not difficult to use but only tedious. The other reason is because I cannot make myself believe that these little molecules of iron are more badly squeezed because their neighbors lie in a curved line than if they are in a straight line. I'll admit that some experiments on hooks seem to indicate a variance from theoretical conditions, but I cannot see through the explanations thus far offered. If someone would give the results of experiments reduced to such a form that, for a given radius of curvature of the neutral line, the computed strength of the structure should be reduced such a per cent., then I would feel as if we had something that we could use even if we did not know why.

Now of course I know that the above may legitimately call out that quotation about those with "little knowledge." However, since that seems to be the state of all of us, except that mythical half a dozen, the only chance to get ahead is for some of us to make sacrifice hits, as it were, and show off our ignorance so that others may profit by it if not by our knowledge.

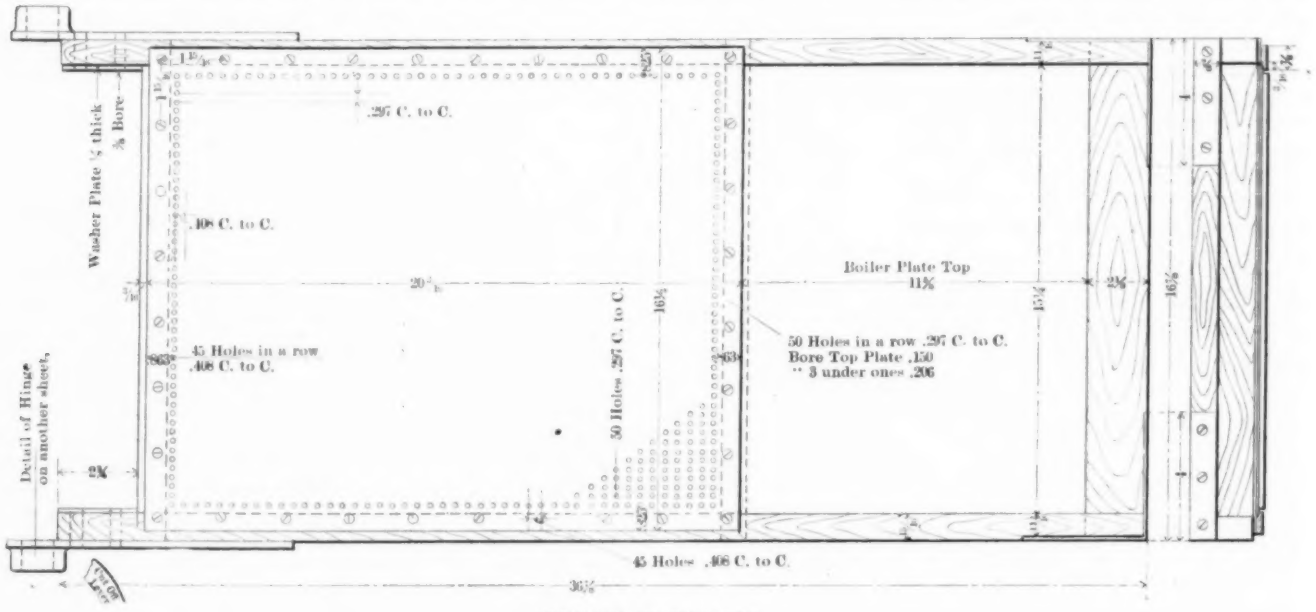
Accurate Spacing Jigs

By F. C. Mason

John E. Sweet's recent article on a simple method of dial graduation recalled to my mind a difficult job that I once saw accomplished in a very satisfactory manner. The method employed was exactly the same, although the people doing the work thought that it was original with them.

I made the drawings for the machine, which was for separating match sticks and introducing them into the clamp racks which held them while they were dipped into the chemical solution for making the head. Each rack, when full, would contain 2250 matches.

Fig 1 shows the top elevation and the brass plate to be drilled. The upper and lower plates were exactly the same and joined together with brass tubes sweated in. These plates had to be made extremely accurate, as there are several more parts that must register with the holes both crosswise and longitudinally. They of course must be interchangeable. For spacing the holes, they used the bushing method.


.297 C. to C.
.408 C. to C.
Washer Plate ⅛ thick
⅜ Bore
Boiler Plate Top
11⅝
45 Holes in a row
.408 C. to C.
50 Holes .297 C. to C.
50 Holes in a row .297 C. to C.
Bore Top Plate .150
" 3 under ones .206
Detail of Hinge
on another sheet.
45 Holes .408 C. to C.

ACCURATE SPACING JIGS

They made 45 bushings hardened and ground 0.408 outside diameter, bore 0.185, and 50 bushings 0.297 outside diameter, bore 0.185. These bushings were held in a slotted machine-steel clamp which had sides parallel with the slot. After making the bushings as near to size as possible with the micrometer, they were clamped together and measured for error; if any was found, it was corrected.

There were two of these jigs, one with 50 holes and the other with 45. The plates to be drilled were squared. The 45-hole jig was clamped on one edge and a row of holes drilled. Then the 50-hole jig

was put on; the first hole registered by a pin introduced through the jig into the corner hole. This was repeated on each side of the plate. After we had the outside rows drilled, we of course had a positive index for drilling the rest, as you could take either jig, introduce a pin in each end and drill the remaining holes.

These jigs were cheap to make, accurate and efficient, and accomplished a purpose which I think could not be carried out in any other way.

Method of Producing Bodies with Spiral Holes

By E. D. Sewall

A sinuous or spiral hole is difficult to make. Bodies having such holes through them are sometimes needed and may be cheaply produced by the following simple method with the hole of any desired cross section.

Having determined the cross sectional shape of the opening and the general outside shape of the body, dies may be procured having a form corresponding thereto and adapted to cut out such shapes. A sheet of the metal desired, of say fourteen gage thickness, may then be taken and perforated disks or planchettes blanked from it by the dies all having the same shape and identical perforations.

Assuming that it is desired to make a driving nut for a spiral tool driver, round disks may be stamped from the metal sheet each having a perforation corresponding to the cross section of the spiral shank of the driver. Any desired number of these identical perforated blanks may then be threaded over the spiral shank and firmly united together by brazing or otherwise, Fig. 1. Any kind of a handle for operating the nut may be fitted over the cylindrical exterior of the driving nut thus formed. Any cross sectional form of spiral, even the most complicated, may thus be cheaply formed in any quantity, a separate die being of course required for each separate cross sectional shape. With blanks formed by one die, bodies having openings of a certain cross section and of all degrees of spiral pitch, within quite wide limits, may be formed, each corresponding to the pitch of the particular former selected upon which they may be assembled.

Spiral milling cutters may also be made cheaply by the same method Fig. 2. By the use of one die any number of cutter bodies adapted to hold cutters having any desired spirality may be produced. Milling cutters thus made have been in use in France. In making cutters by this process disks may be stamped from sheet steel, each disk having a central opening for the arbor and dovetail notches symmetrically spaced about its edge, each notch corresponding in size and shape to the blade designed to be seated therein. The spiral pitch of the blades may be determined and all bent so as to be exact duplicates by the same bending die. The arbor and blades may then be fixed on end on a base, in proper concentric relation with each other, and the disks assembled successively over the arbor, each dovetail notch embracing the inner dovetail edge of its cutting blade. The disks may then be brazed or bolted firmly together or electrically welded and the blades ground and finished.

A spiral milling cutter may also be made by assembling a suitable number of stamped disks, as described, over an arbor

FIG. 1

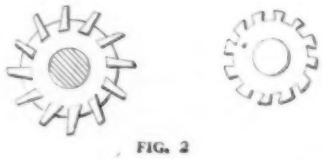


FIG. 2

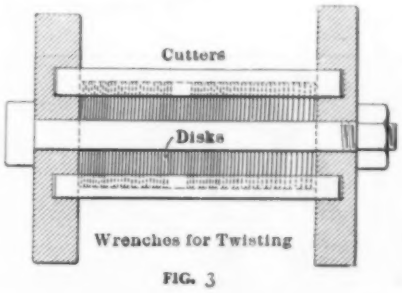


FIG. 3

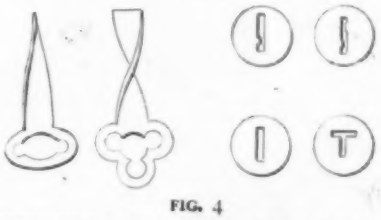


FIG. 4

PRODUCING SPIRAL HOLES AND REAMERS

and straight blades, allowing the arbor and blades to project at opposite ends of the body formed of the assembled disks. The body and blades may then be heated and a wrench member, having an opening to receive the arbor and concentrically located sockets adapted to receive the projecting ends of the blades, applied to the opposite ends of the assembled parts. By then rotating the wrench members in opposite directions the desired degree of spirality may be imparted to the cutters. The disks may then be brazed together (Fig. 3) and the blades tempered and ground.

This method has also rendered available a very useful improvement in locks of the Yale type adapted to be operated by a spiral key Fig. 4. The number of combinations possible with the ordinary Yale lock and key may be endlessly multiplied by repeating each series of combinations with a key of different spiral pitch through all the degrees of spirality available. Again, the key barrel may have the cross section of a letter, and an indefinite number of locks provided each characterized by the same letter and opened by a different key. Thus a large residence or great hotel may have on each door a lock wherein the keyhole may be the initial letter of the name of the owner or proprietor or of the name of the hotel.

The Motorcycle a Vehicle of Remarkably Low Fuel Cost

Whatever may be said of the extravagance of the motor car as a form of amusement, the remarkable economy of the motor cycle as a means of conveyance must be acknowledged. A 190-mile journey by power at a fuel cost of 27 cents, or practically 1/7 cent per mile, is a recent performance of this vehicle. The exact consumption of gasolene was 4 quarts 10 ounces; in figuring the cost 16 ounces to the pint, and 25 cents per gallon for gasolene, were taken. This record was made by Fred. A. Baker in an economy contest on Long Island on September 15, on a 2¼-horse-power single-cylinder Indian, the machine weighing 140 pounds and the rider 150 pounds. The railroad fare for the distance is given at $4.53 and the best record by automobile $3.53.

At a recent meeting of the Institution of Civil Engineers in England the question of the chemical composition of steel rails in order to insure the highest durability and perfection was considered. An opinion was expressed by one of the members that a universal specification for rails which would suit all cases could not be arrived at owing to the varying conditions of manufacture and service. A high percentage of phosphorus constitutes an element of danger in spite of the good wearing qualities of high phosphoric rails, and sulphur is always liable to cause incipient flaws. No more manganese should be allowed than is necessary for clean rolling, as many cases of rail fracture are attributable to high manganese, while an excess of silicon produces brittleness and irregularity of percentage. Engineers now limit the silicon to 0.1 per cent. or even less. The effect of added silicon is different from silicon left in the pig iron, and when the silicon from the pig iron had been eliminated as far as possible and a known quantity of this substance added in the form of high-percentage silico-spiegel or ferro-silicon, the silicon toughened the steel.

Practical Letters From Our Readers

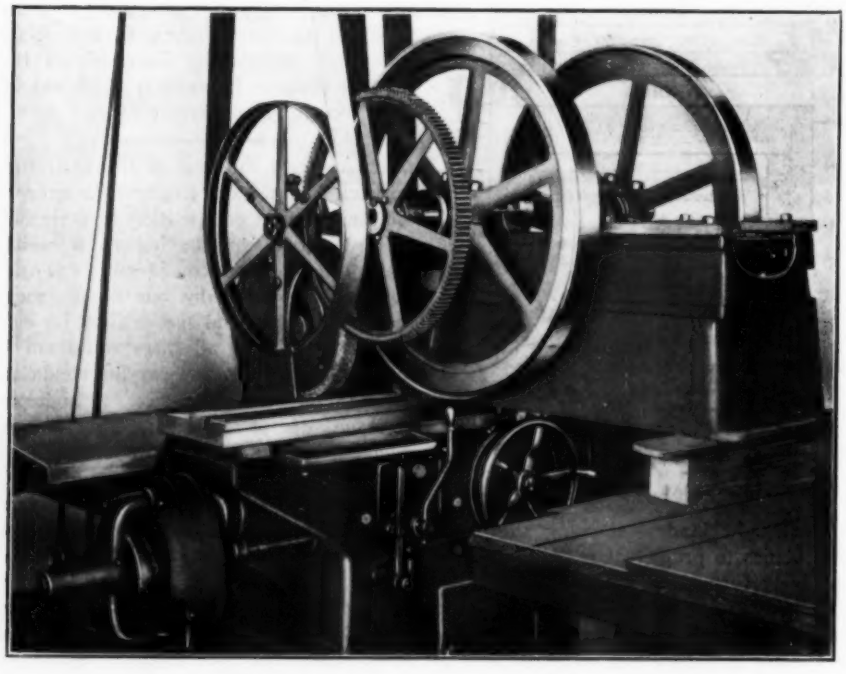
A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Large Grinding Job on a Small Machine

The accompanying illustration shows a gasolene engine placed on a small grinding machine to have the face and edge of pulleys or fly-wheels trued up. The firm which manufactures these engines has never been able to get true-running pulleys. These pulleys have a split hub and, while they run true on the arbor after turning, they run out of true when placed on the engine. The head and foot-stock were taken off the grinder, the engine was placed in position and securely clamped to the bed.

The mechanism for driving the work is somewhat ingenious, the novel or special feature is that the tension of the driving belt is increased with the increase of the grinding load. This fixture consists of a large gear placed on the end of the crank fixture which engages a small pinion on the driving-pulley spindle. The bearing of this spindle is held by an arm which is also mounted loosely on the crank-shaft next to the gear. When driving, the direction of motion of the pulley is away from the work with the pinion driving against the under side of the teeth of the large gear, therefore the effect of tightening the belt with the increase of the grinding load can be clearly seen.



GRINDING LARGE GASOLENE ENGINE FLY-WHEELS ON A SMALL GRINDER

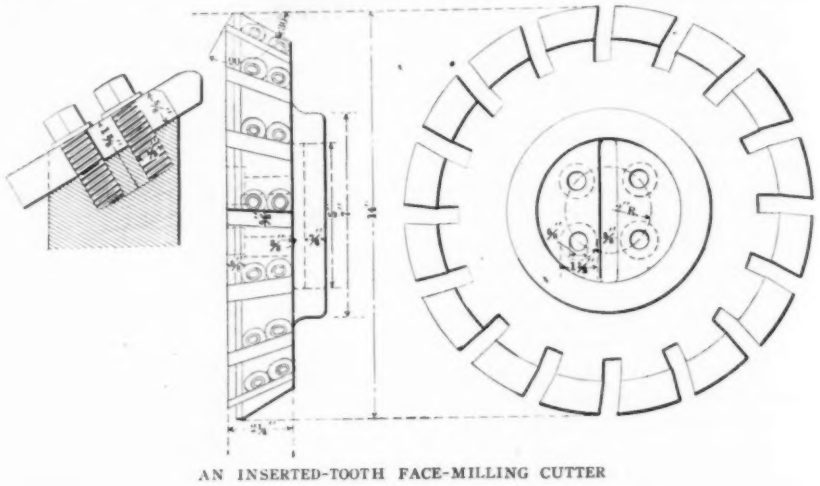
The pulleys, which were 3 feet in diameter and 2½ inches wide, were both ground in one hour, removing 3/16 inch from the diameter and ⅛ inch from the edge. These surfaces were in their rough state. During the operation the bed of the engine was not disturbed. The wheel traversed along the work without any interference. The wheel center was 12 inches lower than the work center, but this in no way affected the grinding. This method may be of some interest to gasolene-engine builders, as they no doubt experience difficulty in getting their pulleys perfectly true.

This job was done on a No. 23 Landis grinder, capacity 12x42 inches. The wheel used was a 24/36 L vitrified, of American make.

J. H. HOLLINGER.

An Inserted-tooth Face-milling Cutter

Robt. R. Keith has an article at page 20, Vol. 30, Part 2, describing an inserted-tooth face mill which, although it has some very good points and undoubtedly will do all that is claimed for it, I think falls far short of being the ideal face mill for the average shop.



AN INSERTED-TOOTH FACE-MILLING CUTTER

The wedges and screws projecting so far (nearly 1½ inches) beyond the cutting edge is a very objectionable feature, as it would prevent the cutter from getting anywhere near a corner, and consequently prevent its use on about 25 per cent. of the jobs in most shops. Then his system of holding the cutter in the body is too elaborate. I fail to see what is to be gained by using the wedges, and there is entailed the extra cost of making them and the trouble of putting them in.

The inclosed sketch shows a 14-inch face mill devoid of all frills and ruffles, but which has been in constant use for the past six months and has given entire satisfaction. The system of holding the cutters is as simple as it is possible to get and have them hold, and the fact that we have broken several ⅝-inch square cutters and never had one slip back is evidence enough that the cutters cannot move. The slots are milled a good snug fit for ⅝-inch square tool steel and the holes for the collar screws are counterbored about 1/32 inch below the top of the cutter so the screw will tighten up on the cutter before it strikes its seat in the body. The cutters are ground to a gage and set in the body to another gage so

that when one set gets dull another can be put in with the assurance that each cutter will do its share of the work. The cutters are ground like a lathe roughing tool, leaving a round nose and doing away with all sharp corners, which, I believe, is the cause of most face mills getting dull so soon: the sharp corner burns off and leaves the cutter without any cutting edge.

With a cutter ground in the shape here shown, it is possible to remove ½ inch of cast steel at a cut with a feed of 2 inches per minute, and if some good drill compound be used to flood the cutter, it is remarkable how long a set of cutters will last without sharpening.

H. M. L.

A Diemakers' Square

The accompanying illustration shows a tool useful for die work.

Fig. 1 shows the tool assembled. Fig. 2 shows one of the two sides, which are riveted together to form the stock. Fig. 4 shows the arm, which is pivoted at *P*, and is clamped to the stock by the larger of the two nurled nuts screwed against the plate, shown in Fig. 5. The blade is clamped to this arm by the hooked rod, shown in Fig. 3, when the small nurled nut is screwed up against the threaded end of the arm. A very thin and narrow blade used with the small block *B* (see Fig. 6) is used where there is not room for the larger blade. On the stock and the small plate are zero lines to indicate when the blade is set at a right angle to the stock; the other three lines indicate angles of one, two and three degrees.

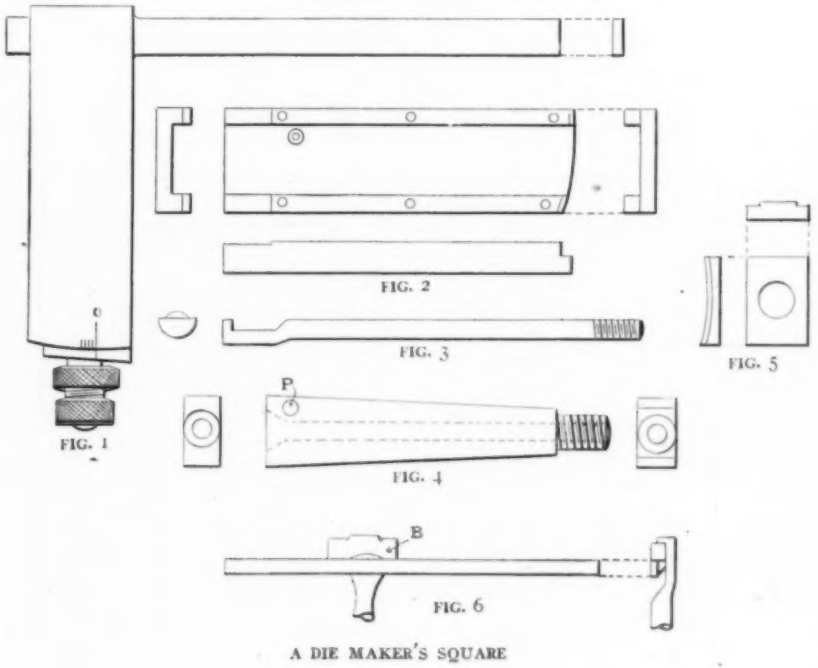


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

A DIE MAKER'S SQUARE

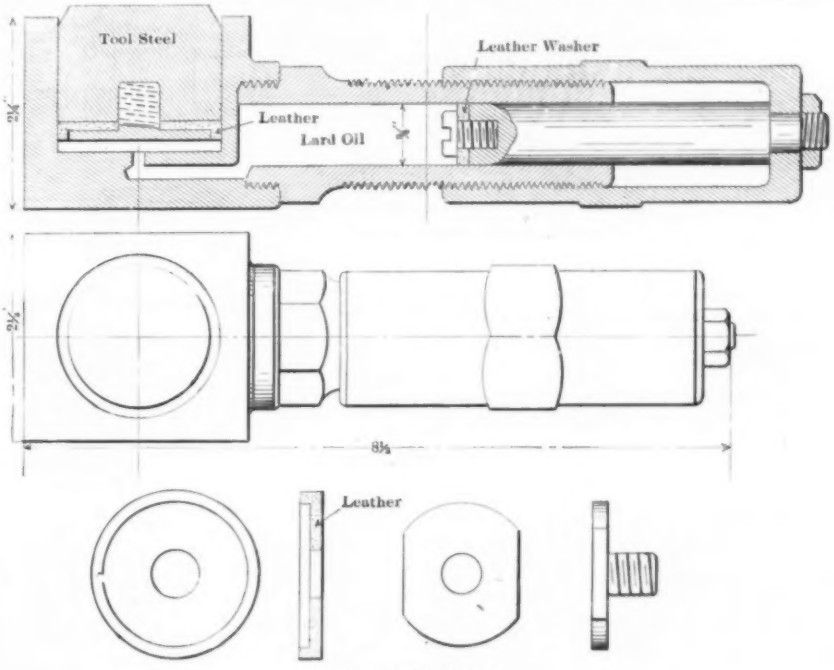
This tool is used much as the small squares in common use, but has the additional advantage that the arm can be set at an angle and the blade moved independently of the arm, as may be required. With the two blades this tool has a wide range of usefulness in die making.

M. H. BALL.

A Hydraulic Press

The illustration shows a hydraulic press which is simple to construct. While simple, it is powerful; and all balky crankpins, large tapers that have been home for many a year, move on when this is put behind them. Its compactness fits it to almost any place where force is needed. I have used this in making forced fits as well.

W. B. TEAL.



A HYDRAULIC PRESS

A Stock Scrap Heap

We often read in your columns of toolmakers and machinists paying visits to the junk pile and rescuing some poor old jig or fixture which had outlived its usefulness, or maybe had been supplanted by something newer or more up to date, and converting it in its turn into something newer to supplant something else.

Now to my mind the best junk pile that the toolroom foreman can have is a few slabs of good gray iron. In a shop where I once worked we had a foreman who insisted on having a pattern made for every jig and fixing he ever designed. With the advent of another foreman, patterns were made for gray-iron slabs to finish 24x24x3 inches, 24x12x3 inches, 18x12x2 inches, also for gray-iron bars 3x2 inches, 2x1 inches, 2x2 inches, 3x3 inches, and 3 inches and 2 inches round. These bars were about 18 inches long. The idea at first was not to oust the patternmaking, but always to have a supply of material on hand. Eventually it did supersede a lot of the patternmaking.

The shop had no foundry of its own, and the new foreman found that to have a pattern made, sent to foundry, and a casting made from it, used to take up about a week's time—time enough very often to have done the job. With the slabs and bars in stock, he always had a junk pile to run to in an emergency.

WILFRID GEORGE.

Lapping—Erratum

On page 325 near the bottom of the first column the statement is made that "ring gages are first ground within 0.005 inch of

size." This should have been printed 0.0005 inch of size.

A Square-thread Tap

Having a large number of nuts to tap with 1 inch diameter 0.5 inch pitch, double square thread, thickness of nut 2.5 inches, it was suggested that they should be done under the drill press, instead of, as formerly, roughing out in the lathe and finishing in the lathe by hand with a tap made for sizing purposes only. The old method occupied about 40 minutes each for the screwing and tapping operations, and it was estimated that a saving of 40 per cent. would result from the new method. The job was passed to the shop with instructions to tap the hole. To those responsible for the change in method, it seemed to savor of simplicity itself; but those who have tried square-thread tapping could tell a different tale, and Mr. Shop Foreman was not to be caught napping.

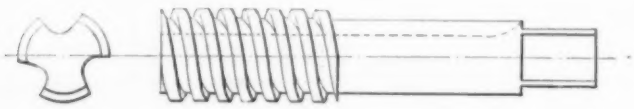


FIG. 1

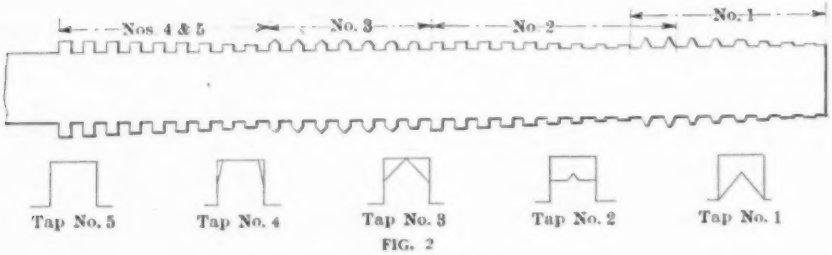


FIG. 2

A NOVEL SQUARE-THREAD TAP

As trouble is very seldom experienced with V-threads, it was decided to take the surplus material out in five operations. On the first tap a V-thread was cut two-thirds of the depth of the thread; with the second it was squared out to half the depth (the second tap having two threads the same shape and size as the large end of the first tap). On the third tap a V-thread was cut to the full depth, followed by the fourth tap, leaving a little to come out of the sides with the fifth and finishing tap. A portion of the tap before grooving is shown at Fig. 1.

It was found by experiment that the thread part of the tap should be about 7 inches long and the plain part just long enough to go through the nut. The cutting edge was at right angles to the thread, making a spiral of about 24 inches pitch, the grooves being continued, as shown by the dotted lines, nearly to the square, to allow a plentiful supply of lubricant to reach the cutting edges till the tap had finished cutting.

The taps were so arranged that one began cutting where the preceding one finished, so that the work was properly distributed over the whole length of the four roughing-out taps, as illustrated at Fig. 2, the plan of the operation being illustrated in one long tap which is shortened up to allow of the whole operation being shown with the finishing sizes of the several taps.

The nuts were drop forgings made from a good quality of machinery steel and had to pass the gage with a limit of 0.002. The time taken to tap the nut was 17 minutes, a saving of 58 per cent.; but on another operation the drill press lost some time, so that the ultimate saving was 50 per cent., minus the cost of taps.

M. M. SHARP.

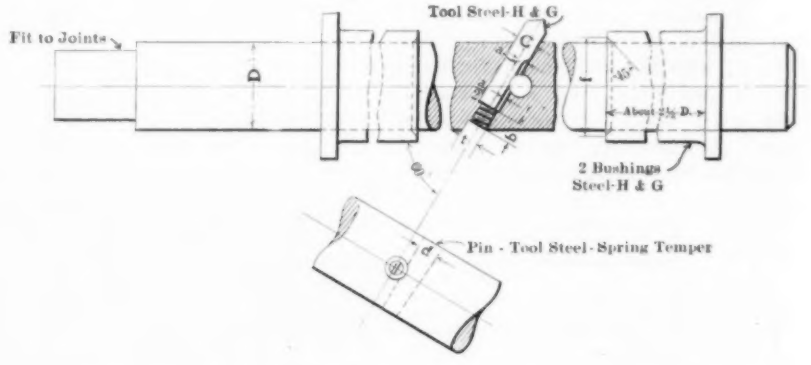
Boring Bars

Reading the article lately contributed by Dixie, on boring bars and cutters, made me think of a style used by a large firm in this country.

As shown in Fig. 1, they are single-ended cutters, and on that account may not be able to do an accurate job as Dixie's. They are, however, used on some pretty fine work, boring lathe heads, etc.

The difficulties experienced in guiding the double-end cutters and the setting of these exactly central in the bar so they will divide the chip (their principal good point), make their use undesirable in many shops.

The single-point cutters can be set very accurately by the help of a micrometer; all that is necessary, of course, is to gage from the point of the cutter to the oppo-



D	C	d	a	½a	s	t	b	f
Dia. of Bar	Dia. of Cutter	Dia. of Pin		Flat	Dia. of Screw	Dia. of C'bore	Length of Thread	Dia. of Chamfer
⅜	½	3/16	1/32	3/64	1/16	3/8	5/64	3/16
7/16	½	3/16	3/32	3/64	1/16	1/2	5/64	3/16
½	½	7/32	3/32	3/64	1/16	1/2	5/64	5/16
9/16	½	1/4	3/32	3/64	1/16	9/16	1/8	13/32
5/8	1/2	1/4	3/32	3/64	1/16	9/16	1/8	3/8
11/16	5/8	5/16	3/32	3/64	1/16	5/8	3/16	15/32
3/4	5/8	5/16	3/32	3/64	1/16	5/8	3/16	7/16
13/16	3/4	5/16	3/32	3/64	1/16	3/4	3/16	15/32
7/8	3/4	5/16	3/32	3/64	1/16	3/4	3/16	1
15/16	3/4	3/8	3/32	3/64	1/16	3/4	3/16	1 1/16
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1 5/16	3/4	1/4	1/32	1/64	1/16	3/4	5/16	1 5/16
1 3/8	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 7/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 1/2	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 9/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 5/8	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 11/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 3/4	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 13/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 7/8	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
1 15/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
2	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
2 1/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
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2 1/4	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
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2 3/8	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
2 7/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
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2 5/8	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
2 11/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
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2 13/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
2 7/8	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
2 15/16	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16
3	7/8	5/16	1/32	1/64	1/16	7/8	3/8	1 7/16

FIG. I. STANDARD BORING BARS

site side of the bar. The diameter of the hole will be found by subtracting the diameter of the bar from this size and adding the difference thus found to the first measurement.

After being adjusted by the screws in back, the cutter is locked by a pin. This is a plain cylindrical pin and a flat taper is ground on one side, this side, of course, going against the cutter.

The bars are not secured to the boring-mill spindle, but are used with fixtures and are lined up by bushings.

The couplings between the spindle and the boring bar are shown in Fig. 2.

These couplings are made fast to the boring-mill spindle, or taper arbor in the spindle, by a taper pin. The boring bar is driven by a pin which fits into a slot in the coupling in which it is held by a nut.

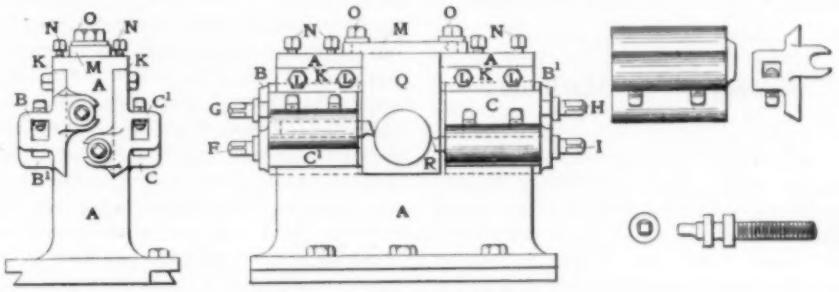
The bar can be removed and another one used by simply giving this nut a quarter turn, making it very handy.

G. R. RICHARDS.

A Rest for Turning Shafting

The illustrations show a rest for turning shafting, piston rods, etc. It can be made to suit any lathe intended for such work, being very much quicker than an ordinary slide rest, operating a single tool. The rest here described will finish heavy forged piston rods 4 inches diameter at one cut.

To use this rest the ordinary compound slide rest should be removed. After the shaft has been turned to fit the

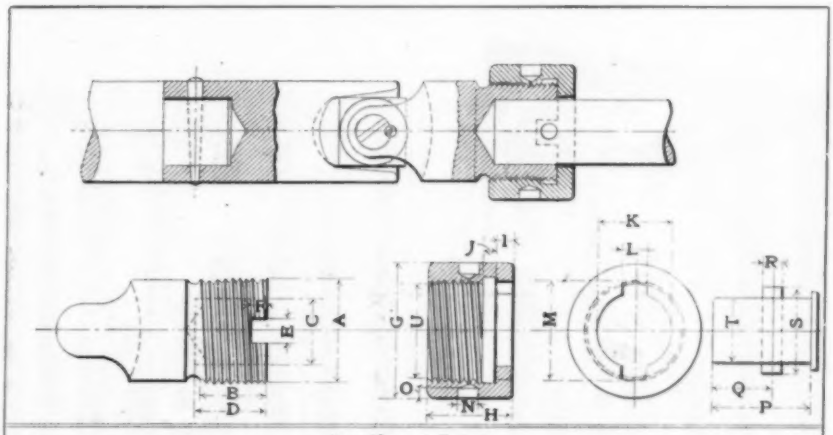


A REST FOR TURNING SHAFTING

steady-rest dies *Q* and *R* for about 3 inches from the end, the rest is placed on the carriage, and is locked in position by the set screws and strip shown for that purpose. *A* is a gray-iron casting. *B*, *B*1, *C* and *C*1 are malleable castings, for carrying the cutting tools, planed to fit the slides in *A*. *F*, *G*, *H* and *I* are the adjusting screws for regulating the depth of cut. *K* are the adjusting strips for the tool boxes, *L* being the screws for securing them, and *N* the screws for the vertical adjustment. *M* is a swinging top cross bar, with a slotted end, *O* being the pivot screw, and *P* the securing screw, for fastening the two gray-iron steady dies *Q* and *R* which are interchangeable for different sizes of work, and are bored out in position, to insure their being dead central. Four tools can be in operation at the same time, if necessary—two at the back and two at the front—although this is seldom necessary, three generally being sufficient—two in front of the steady dies, to give the work a good round surface to allow it to pass through the steady, and a finishing tool behind. A drip can should be carried on the top, to allow oil to drop on the shaft, just in front of the steady dies, so as to prevent any excessive friction.

JOHN TURNER.

London, England.



A = Size of Joint

12 Threads per Inch for all Sizes.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
¾	⅝	⅝	7/16	3/16	5/32	1	⅝	⅛	3/32	17/32	3/16	11/16	9/64	⅜	¾	⅜	⅛	21/32
1	⅝	⅝	9/16	¼	7/32	1⅜	⅝	5/32	7/32	21/32	¾	15/16	11/64	3/32	⅞	15/32	5/16	⅞
1¼	⅝	¾	⅝	5/16	5/32	1⅝	13/16	⅛	⅛	25/32	5/16	1 5/32	13/64	3/32	1⅛	⅜	⅛	1 5/16
1⅜	13/16	1	⅞	7/16	13/32	2	1 1/16	¼	⅛	1 1/32	7/16	1 13/32	15/64	7/32	1⅜	11/16	⅜	1 5/16
2⅜	⅞	1⅜	1⅛	½	17/32	3	1⅝	¼	⅛	1 17/32	7/16	2⅜	17/64	7/32	1⅞	1⅛	⅜	2⅛
3	⅞	1⅞	1¾	11/16	21/32	3⅜	1¼	¼	⅛	1 25/32	11/16	2⅞	21/64	½	2 3/16	1 5/16	½	2⅜

A	T	U = Bore for Thread	Used on Bars
¾	0.499	0.6610	⅝ to ⅞
1	0.624	0.9110	⅞ to 1¼
1¼	0.749	1.1615	1¼ to 1
1⅜	0.999	1.4115	1 to 1½
2⅜	1.4985	2.4115	1½ to 2
3	1.8735	2.9115	2 and over

FIG. 2. BORING BAR UNIVERSAL JOINT COUPLING

Fine Adjustment for Boring Bar

I am very much interested in M. M. Sharpe's adjustable boring tool, on pages 344 and 345, current volume. His description of the tool is very clear, but I do not understand how he was able to graduate the circumference of the sleeve *C* and the ring *D* to obtain such a fine adjustment as 0.001 of an inch. I cannot see how he was able to get the graduations spaced respectively to the movement of the cutter at the various positions of the sleeve. That is, he will have to move his sleeve

a greater distance at the lowest point of the eccentric than he will at the quarter turn in order to move the cutter 0.001 of an inch. This, of course, would require irregular spacing around the circumference at the sleeve.

I would be pleased to have Mr. Sharpe go into detail as to what method he used to get his fine adjustment.

J. H. HAMMOND.

Photographing Machinery

The size of plate to be used depends on the nature of the machinery or part to be photographed and on the size of engraving wanted. For simple parts without much detail, 4x5 inches or smaller may be large enough, but for a steam engine or machine tool 8x10 inches should be used, and even larger for a printing press. In any case the photograph should not be smaller than the engraving wanted. It is advisable to print on one or two sizes larger paper to give the engraver room for changes, additions, etc. Optical enlargements are not worth considering.

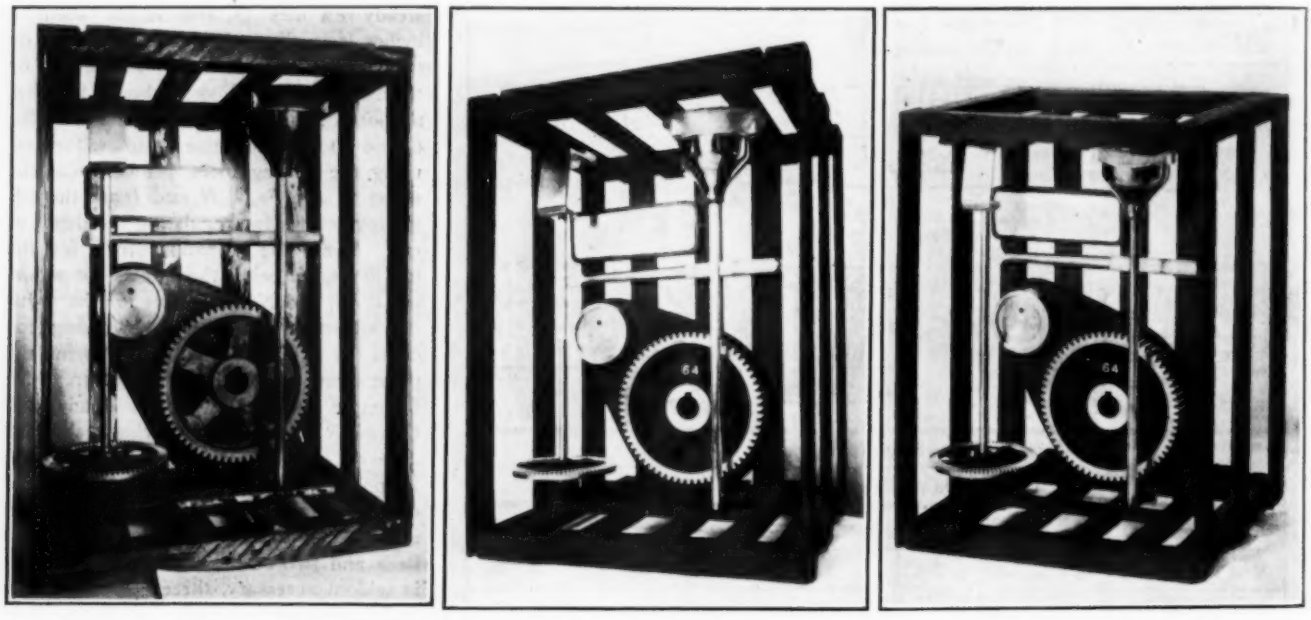
The lighting usually presents difficulties in the average shop, owing to limited space and scattered windows. Light as provided in a studio is useless for machinery, as it fails to show detail. An angle of from 10 to 15 degrees to one side of and above the camera is about right, but there should be some supplemental direct top light used sparingly. Side lights are to be avoided. Direct sunlight on the object or near it will cause failure. Magnesium or flashlight can be used to increase the light, but it should be spread out over some square feet of area and not be confined to one point. Every vestige of smoke must be cleared away before another exposure is made; otherwise the photograph will be dull and flat. Mirrors or reflectors can be set up to throw light into dark corners and recesses, but only where it is impossible to obtain enough front light. Screens or curtains should be arranged to exclude all that is not wanted, and the floor be covered with cloth or paper so that all projecting parts will show against a contrasting background. An inspection of most half-tone engravings of machinery will show that they are "outlined" or "vignetted," in either case the original background being cut away. To assist the engraver doing this cutting, the background should furnish as much contrast as possible, and a dark curtain may sometimes be better than a white one. A combination of both may in some cases be of advantage, but usually one kind is all that is required.

Considerable judgment is needed in the choice of position, and it is often necessary to take several views before one is found that is satisfactory. Some photographic literature leaves the impression that difference in length of focus of lens affects the perspective. This is not so; it merely alters the size of the image. The camera should be set, where possible, at least three times as far away from the object as it is across its widest or highest parts, and about on a level with the eyes from the floor line; a lens of sufficiently long focus to fill the plate should be used. This may require a long draw, in which the average camera usually is deficient.

With some objects, such as vertical boring mills, chucks and special tools with horizontal center lines or other familiar marks, it is possible to illustrate different sizes by change of position. With the camera near and low they will look large, and with it far away and high they will look small; but such treatment will not do for standard lathes, milling machines, etc. This is shown in Figs. 2 and 3.

Hand wheels, cylinder heads and similar round parts should be finished in the lathe with emery cloth, avoiding gloss. Shafts and rods can be buffed or polished, but a lengthwise finish with emery cloth is probably best. Cups and other round parts of brass should be highly polished—see Figs. 2 and 3. Rectangular flat polished surfaces should be painted white or rubbed with putty, otherwise they will show undesirable reflections or destroy surrounding details by halation, as shown in Fig. 1. When painted they will show up dull and flat in the photograph, but this is a case where it is best to fall back on the engraver for proper finish. When fancy scraping is to show, the surface can be rubbed with putty to take off the gloss, but it is difficult to do right. Spots and finger marks must be carefully avoided, as they are quite capable of ruining an otherwise good photograph.

If windows or openings show light on the ground glass, they must be stopped up or the photograph may be ruined by halation. It pays to take every precaution to insure a first-class photograph, as there is nothing about the various processes that will make an engraving better than the original. This is not the same as saying that a photograph cannot be bettered, for, as a matter of fact, it is impossible to make one that an artist will not in every way improve; but his work should be confined to improvement and not wasted in correcting faults. Fig. 1 shows a case where everything is neglected and a large amount of work would be required to make it passable. The lighting is also from the wrong side. Figs. 2 and 3 are properly finished and lighted, and the artist would only have to emphasize high lights and shadows.



FIGS. 1, 2 AND 3. PHOTOGRAPHING MACHINERY

Painted surfaces should be matt and without sign of gloss. Black is best, but drab is also useful and common. Good results are obtained from white, but much of that would no doubt prove tiresome. Gear wheels and their teeth seldom receive the attention they ought to have. The teeth should be painted with aluminum bronze powder mixed with turpentine, and this treatment is good for any surface that is to show a clean cut without any other finish.

No attempt should be made to differentiate between different planes or parts by change of color or such means. Give it the proper lighting and leave the rest to the artist.

Extreme sharpness of detail and depth of field are necessary, and as these can be had in any lens only by stopping down, a high-priced lens is not called for. An ordinary good rectilinear will answer all requirements, and costly anastigmats are of no advantage for this work.

Focus at half way between nearest and farthest point of view, using F-8 stop and expose at F-22 or F-32. Exposure will run into minutes, so everything connected with it must be free from vibration to insure sharpness.

Development of the plate is to many a mystery and bugaboo, but this should not be so, as it is strictly a chemical process and merely a matter of formula. No developer has any advantage over any other so far as final results are concerned. The easiest and best way to develop is by the factorial system, which deserves more general application than it now enjoys. Briefly it may be stated that it is based on the fact that the finish of development bears a certain time relation to some other stage of it, and this ratio varies with different developers, but is constant with each. The time between pouring on of the solution and the first appearance of the image is taken as one factor, and the particular developer used furnishes another. The developer factor is independent of dilution and temperature except with Pyro, where it varies with dilution, but is independent of temperature. If a developer having a factor of 10 is used, and in it the image just appears in 25 seconds we multiply 10x25; without any more attention except rocking, take the plate out after 250 seconds from the time it was put in, and it will be found that no amount of attention or worry could have made it better.

By this system a positive check can be had on both exposure and development. because over or under exposure will show in a way that cannot be mistaken; supposing that the exposure is correct, but the plates come out too dense or too light, it is only necessary to change the factor to suit, after which the results will be uniform. It is better to use developers for plates more diluted than the formulas call for. Doping them with bromides and such stuff is useless. H. FARNUM.

Another Large Glass-grinding Disk

Noting a description in a recent number of your paper of a method of finishing a large face plate used in grinding and polishing glass, the following views may be of interest in showing how a similar plate was finished in one of our local shops. As there was in the shop no lathe which could be spared at the time, the foreman utilized a large Beaman & Smith horizontal boring mill.

He first had a large auxiliary spindle cast which was finished up and bolted to the face plate of the boring mill. To the end of this spindle was fitted a large face plate to which the plate to be faced was attached. As it made considerable overhang, it was necessary to support the auxiliary spindle, which was done, as the illustrations show, by taking a large pillow block for a bearing, blocking it up to the proper hight and pouring babbitt in it. It will be noted that the pillar block had no cap nor top on it, as it was thought it would support the spindle without it. The plate was about 8 feet 4 or 5 inches, in diameter and weighed a trifle over 3½ tons.

To hold the tool to do the facing, the outer support or column was utilized. A split bushing was fitted in the outer support, which, when clamped in place, held the tool holder. This was a piece of cold-

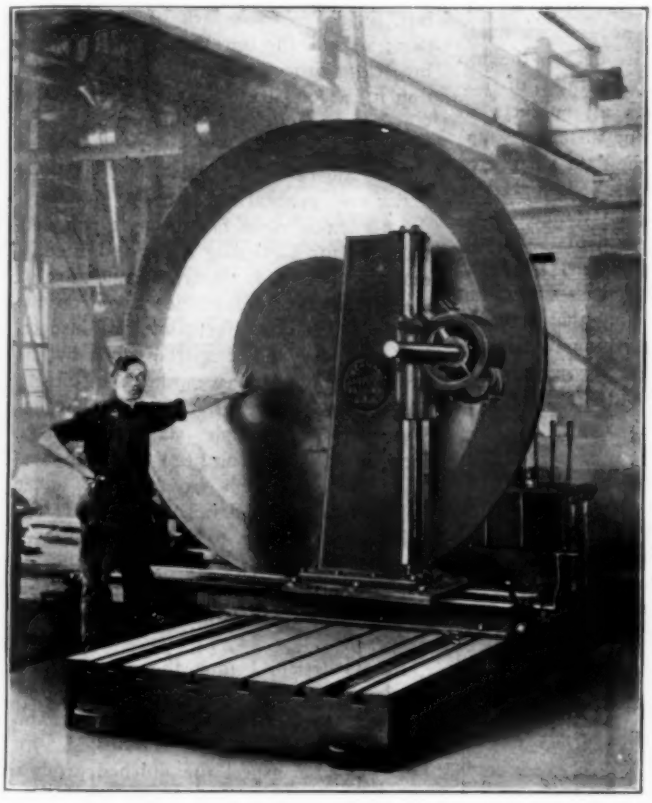


FIG. 1. FACING THE DISK

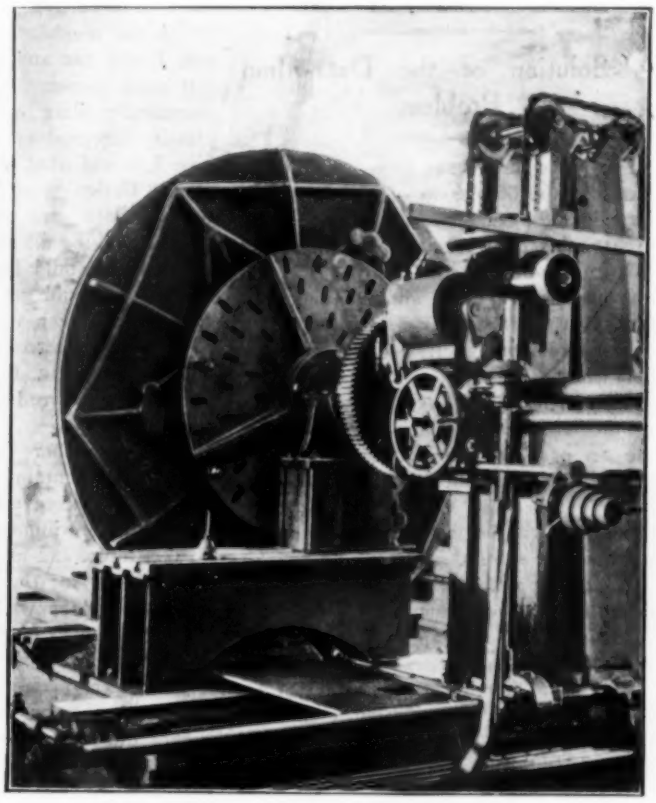


FIG. 2. HOW IT WAS SUPPORTED

rolled stock with a hole put through the end diagonally, similar to an Armstrong boring tool. The feed was made automatic by making an extension at the rear of the cross-feed screw to the screw used to feed the support back and forth, by attaching a pulley to it and belting to the pulleys which are used to finish the regular feeds on the machine. At the time these pictures were taken the automatic feed had not been attached. The method of bolting the plate in position was by drilling holes sideways through the ribs of the plate and using hook bolts, and it proved very satisfactory.

This job was done at the McCan Mechanical Works, Los Angeles, which kindly furnished the views; the plate is for grinding mirrors or lenses for the Mt. Wilson observatory.

ANDREW H. KIMBALL.

A Solution of the Data-filing Problem

For years there have been periodic revivals in the discussion of filing systems for clippings, data, etc. Everyone seems to have his own special method. Some of them involve a vast amount of pasting, making out cards and indexing. In fact, all that I have ever seen, or heard of, require more or less writing for the data filed. I have collected data for years and have tried several well recommended systems but always found that the act of filing required too much detail work to suit me; not because I am lazy, but because I do not like to do things that can be avoided without affecting the final results.

A clipping and data file should fill all of the following requirements:

1. It must be cheap in first cost and cheap in maintenance.

2. It should require no writing of information, index or cross-index cards.

3. All matter should automatically classify itself, thus bringing all data on any given subject together.

4. Everything should be so filed that instant reference and rapid filing are possible.

5. Data should be so marked that they can be easily returned to their correct place.

6. It must be possible to remove dead matter at any time without interfering with the index or necessitating the removal of any cards.

In the first place, when commencing this system, I needed an index that would be complete once and for all; and here I was fortunate in obtaining a copy of Bulletin No. 9 of the University of Illinois. It is entitled "an extension of the Dewey decimal system of classification applied to the engineering industries." It probably contains the most complete relative index on this subject in the world. I feel sure that the university will sell copies at a nominal cost. Of course if I had not been able to get this, I should have either purchased a copy of Dewey's decimal classification or gone to the public library and copied the engineering subjects from the Dewey book; but the bulletin mentioned is undoubtedly far superior to all others. Next I bought 100 common letter folders and found an old soap box that was slightly wider than the folders, to keep them in.

This is all there is to this filing system. When I get data to file, say something in reference to boiler tests, I just look in the relative index for boiler tests, which is 621.187. This number I write on the margin, or other conspicuous part; then neglecting the decimal numbers, I put the data in folder No 621. Should the folder contain other matter, then I place it in 621.187 position; or if a folder of this number has never been made out, I take one and write 621 on the top left-hand corner. This method of automatically filing causes all subjects to classify themselves. For instance, suppose I should want all the data I had filed about "Designing of Cams." The relative index would give me the number 621,-835. By taking all the data of that number, which would be together, from the folder, I should get at once everything that I had ever filed on that subject. When I came across anything that is obsolete or useless, I just throw it away and thus keep weeding out the dead from the live data.

Of course there are times when one article will contain another, or part of another, on the reverse side. In this case I file the more important article under its correct index and in the file under the index number for the second article I put a piece of paper referring across, thus: 621.187, see also (656.324). Or else I file the other sheets of the second article in their correct place and write under the correct number on the margin the number where the balance of the article will be found, thus:

621.187
(656.324).

The second number I always put in brackets to avoid any error in filing.

If a page out of some of the larger mechanical papers is too big for the folder, I fold it. When there are several sheets to file containing one article, I fold the corner and tear a double slot, which I fold back. This I find holds all the papers together as satisfactory as clips and does not catch the other papers; besides it is cheaper. Should one of the folders become filled, say the No. 621, I subdivide it into the first decimal, thus: 621.1, 621.2, 621.3 and so on, and place the data in their new file. Should one of these become filled, through some special study, then I take the second decimal number, thus: 621.10, 621.11, 621.12. If one of these becomes filled, I can take up the third decimal, then the fourth and so on to any minute division necessary. Of course as the data are always fully numbered when filed, there is nothing to do but to put them in the correct new folder. The whole system has not cost me $2 and is giving satisfaction.

GEO. P. PEARCE.

Hardness Standard for Hardened and Tempered Work

It is a pleasure to know that my article in Vol. 30, Part 1, page 845, was amusing to at least one person. Such is the fact, as indicated by Mr. Steel, in his article on page 271. In my article I intended to bring out three points: First, the uncertainty of ordinary hardening-room methods, owing to their lack of standardization; second, the unreliability of ordinary inspecting processes; and third, a suggestion for a comparative inspecting standard which, as far as I have been able to use it, seems to possess elements of merit.

Mr. Steel's article can be considered under two general heads. The first, that the hardening room has to-day a complete standard for hardening steel; and, second, that the file test is uncertain and unreliable. Thus the two articles agree on the point of the unsatisfactoriness of inspecting hardened and tempered work by the ordinary file test. Accepting Mr. Steel's first general proposition that the hardening room has ample standards today, there is, of course, no need of a comparative standard, such as outlined under point three of my article. Therefore the point which is open to discussion between Mr. Steel's article and mine is whether or not the hardening room of today has sufficient standards to carry on the work properly.

In my article I took the position that hardened and tempered work should be finally tested after the hardening and tempering processes were finished. In other words, inspect the finished product of the hardening and tempering room. Mr. Steel seems to take the position that the hardening processes should be standardized, and this being done, the product will be uniform and will need no inspecting or testing whatever. Four elements enter into the hardening and tempering of steel: First, the physical characteristics of the steel itself; second, the temperature and uniformity with which the steel is heated prior to plunging; third, temperature and characteristics of the plunging bath; fourth, the rate of cooling of the piece being hardened.

Now it seems to me that it is easier to inspect one thing, the result, rather than four things, the controlling factors to reach that result. Mr. Steel, of course, knows that changes in the sulphur, phosphorus and manganese contents of steel for a given carbon content will affect the hardening properties. He must also

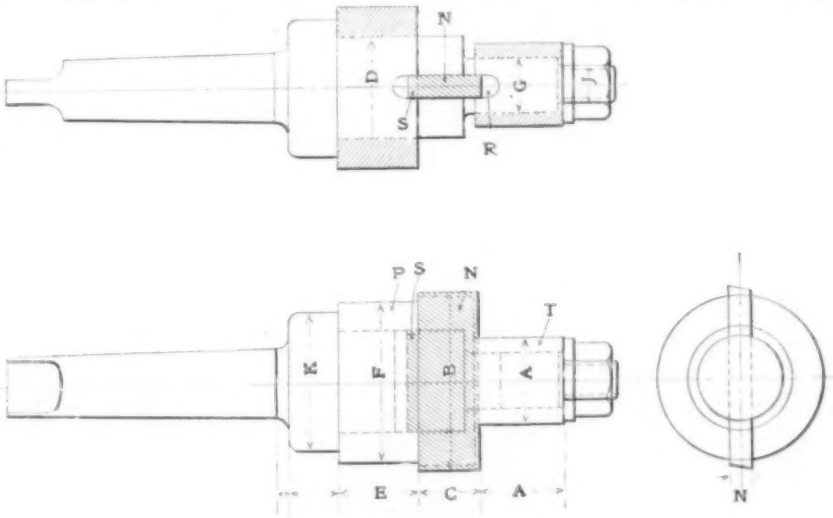
know that with a given chemical mixture a thin piece of steel will harden harder than one of considerable bulk. He must also know that a difference in temperature of a very few degrees, at about the point of recalescence, will make material changes in the hardness result. Also a change of a few degrees in the temperature of the plunging bath will affect the result. It therefore seems to me that it is a good deal of a problem to control all of these factors in the hardening room so that the final result shall be of uniform character and need no final inspection.

In Mr. Steel's article he says, "We have first a given heat for every make of steel, and second, a given heat for every grade of that make." Will not Mr. Steel kindly take up two or three of the standard brands of steel and give us the precise heat for each brand and for each grade of that brand? I am sure that this information will be of great value to the readers of the AMERICAN MACHINIST.

A. L. PRATT.

Facing Cutters and Arbors

The illustrations show two sample arbors with facing cutters for facing around bolt holes and similar work, and the accompanying list gives dimensions for a set of these from ⅜ to 2 inches diameter which are in daily use in our works.



FACING CUTTERS AND ARBORS

A	½"	⅝"	⅝"	¾"	⅞"	1"	1⅛"	1¼"	1⅜"	1½"	1⅝"	1¾"	1⅞"	2"
B	1 5/16"	1 9/16"	1 13/16"	1 15/16"	1 15/16"	2 1/16"	2 5/16"	2 11/16"	2 7/8"	3 1/16"	3 1/4"	3 5/8"	4"	4 1/16"
C	5/16"	3/8"	⅜"	3/8"	½"	¾"	13/16"	⅞"	15/16"	1"	1⅛"	1⅛"	1⅛"	1⅛"
D	⅝"	¾"	⅞"	1"	1⅛"	1⅛"	1⅛"	1⅜"	1⅜"	1⅝"	1¾"	1⅞"	2"	2⅛"
E	⅜"	7/16"	½"	¾"	⅞"	⅞"	1"	1⅛"	1⅛"	1 3/16"	1¼"	1⅜"	1⅜"	1⅜"
F	1 5/16"	1 5/16"	1⅜"	1⅜"	1 5/16"	1 5/16"	2⅛"	2⅛"	2 1/16"	2⅜"	3"	3⅛"	3⅜"	3⅜"
G	⅜"	⅜"	7/16"	⅜"	½"	9/16"	¾"	⅞"	⅞"	1"	1"	1⅛"	1⅛"	1¼"
H	⅛"	⅛"												
J			¼"	¼"	¼"	5/16"	5/16"	5/16"	⅜"	⅜"	⅜"	½"	½"	½"
K	1 1/16"	1 1/16"	1¼"	1⅜"	1 1/16"	1⅜"	1⅜"	1⅜"	2⅛"	2⅛"	2⅛"	2⅜"	2⅜"	2⅜"
N	3/16"	3/16"	¼"	¼"	¼"	5/16"	5/16"	5/16"	⅜"	⅜"	⅜"	½"	½"	½"
Morse Taper Shank	No. 1		No. 2			No. 3			No. 4					

PROPORTIONS OF FACING CUTTERS AND ARBORS

The collar *P* is of hardened steel, forced into its place after the slot *R* for the cutter *N* is made. The face of this collar is then ground true with the arbor.

The cutter *N* is centered by a turned projection *S* which fits into the collar *P*.

The bushings *T* (which are hardened) are made of separate pieces so they can be changed to suit tapping sizes of holes, or enable other than standard work to be dealt with.

T. M. LOWTHIAN.

England.

The Constant-speed Variable-volume Air Compressor

I have read with much interest the description of the Nordberg variable-capacity constant-speed air compressor, on page 249. All that you say of the apparatus is true, and it has other advantages which you do not mention, but which are sometimes important, particularly for mining work, for which it is very likely to be applied. These consist in the fact that the air compressor may be combined with an engine for ordinary power purposes so that a casual glance will not tell it from an ordinary air compressor, but which, nevertheless, gives a variable supply of air at constant speed, while the fact that the speed is constant permits power to be taken from the main shaft either by belting or by direct connection, as may be preferred. We have had such a combined engine in service for several months at the works with which I am connected, and like it very much. The entire plant is not yet completed, so that the power feature has not been used except for some minor purposes as yet; but one of these purposes has been the driving of an electric-light generator, with satisfactory results.

When our present plant is completed, the ore-washing machinery will be driven from a jack shaft, belted directly to the fly-wheel of the compressor, and the centrifugal pump for the water supply for the washer will be driven from the same jack shaft.

The prejudice against combined units of this description is quite widespread and is generally justifiable; but in the present case and in many cases for mining application, the ore-washing plant and the air compressor are, as a rule, always run simultaneously. For if the air compressor were shut down, there would be no air to run the drills and consequently very little ore mined, so that the ore washer would not be needed because such ore as was mined could be stored between the mines and the washer in the cars or in the bins at the latter point. If, on the other hand, the washer were unable to run, the mines could not make much, if any, output, because such storage resources are relatively small and the mine would have to shut down, so would not need any air. In other words, if we had a separate power engine and air compressor, one would usually be compelled to stop when the other did, this being a case where the prejudice against combined units loses its force. On the other hand, important advantages are gained.

In the present case, if we had been compelled to use a separate compressor and power engine, both of them would have been too small to be obtainable in economical types, in addition to being burdened with the lack of economy of small units. By combining the two the size of the unit was such that we could have a Corliss engine, steam jacketed; by running it condensing, as we expect to do, we shall secure a very respectable degree of economy, while the first cost, both of machinery and installation, and the maintenance and attendance cost are all considerably smaller than they would be for two units.

We have installed only the high-pressure side of what will eventually be a compound two-stage machine, the high-pressure cylinder giving power enough to drive the high-pressure air cylinder as a single-stage machine and giving a sufficient amount of power for the other work we have in view. A little later, when we need more air, we shall put in the low-pressure side, which will give us three times the quantity of air and an additional quantity of power from the main shaft, with, of course, a decided increase of economy over our present half unit.

Our opinion is that a unit of this type is practically perfect for such conditions and has a minimum of disadvantages and a maximum of advantages. Incidentally we have taken diagrams of our machinery in actual operation just about as perfect as those shown in your article.

JOHN J. SMITH.

How Many Atoms in a Cubic Inch of Copper?

I note, on page 360, the statement that there are 60,000,000 atoms of copper in a cubic inch of that metal, which would be interesting, as stated, were it true. We could then see them with a 10-cent microscope or even with the naked eye. But it isn't true. I suspect that there was an exponent 3 which was left off. This would make the number as stated some 3,600,000,000,000,000 times too small.

E. J. ARMSTRONG.

Making a Shaper into a Plain Miller

Having a lot of milling-machine work to do and not being able to get a miller for the purpose, I built the attachment shown with this, and it has been in constant use for some time. Although convertible, this is very easily charged and has proved very useful indeed.

To change from shaper to miller, all that is necessary is to take off the nut on the reverse shaft. This will let the reverse lever swing out of the way; then pull out the shaper head or ram. This done, you are ready to put the milling head in the ram slides.

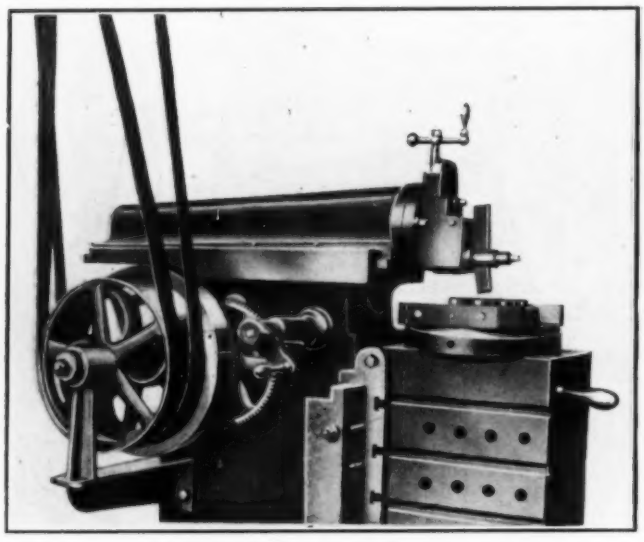


FIG. 1. AS A SHAPER

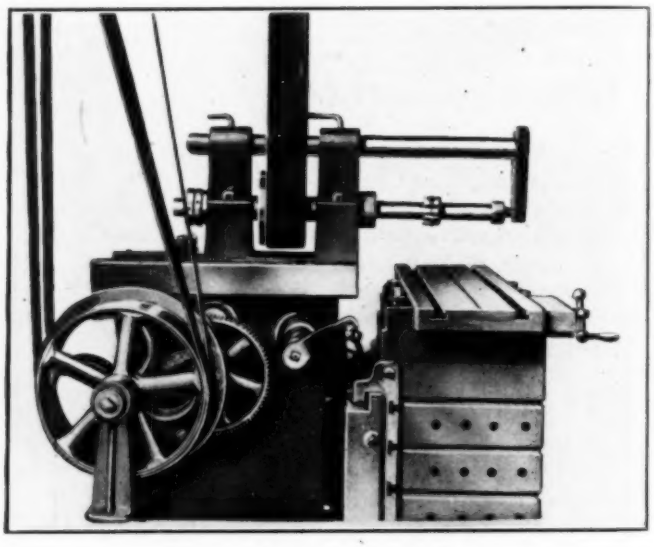


FIG. 2. AS A MILLING MACHINE

Next remove the vise and place the milling bed on the carriage. There is a stud underneath that holds the vise. This same stud holds the bed on the carriage, there being a tongue which makes setting quick, that fits in the slot on the shaper carriage.

I put on the ceiling two countershafts with cone pulleys with five different speeds, driving down with a quarter-turn belt. By putting cone pulleys on the ceiling, the handling of the head is facilitated. It can be changed in five minutes, and even sooner.

The feed is the same as the shaper, the feed reversing with the stroke of the machine. The friction on the feed for the shaper does not turn all the way around, being stopped by the pin on the side of the machine. I remove this pin and in its place put a stud; so, when using the miller, remove the stud; the friction disk revolves around. The connecting-rod to ratchet on the feed screw is then set to the amount of feed wanted.

The capacity in its two capacities is shown in Figs. 1 and 2, and the interesting part is that the complete cost of construction was only $49.

JOHN D. MILLER.

Short-cuts to the Solution of Mechanical Problems

After seeing the outcome of the articles on the above subject, I wonder if an apology from me is not due the readers of the AMERICAN MACHINIST for starting it. As it is customary to let the instigator of a discussion have the last word, I will reply to O. M. Hamilton.

I had thought that there were a great many people who knew the multiplication table and could tell offhand how much 6 times 7 made, but who could not tell without resort to pencil and paper how much 6½ multiplied by 6½ was; and that if I told them a way by which they could multiply 6½ by 6½ just as readily as they could multiply 6 by 7, I was doing them a service provided they ever wanted to multiply 6½ by 6½, or any other number and a half by itself.

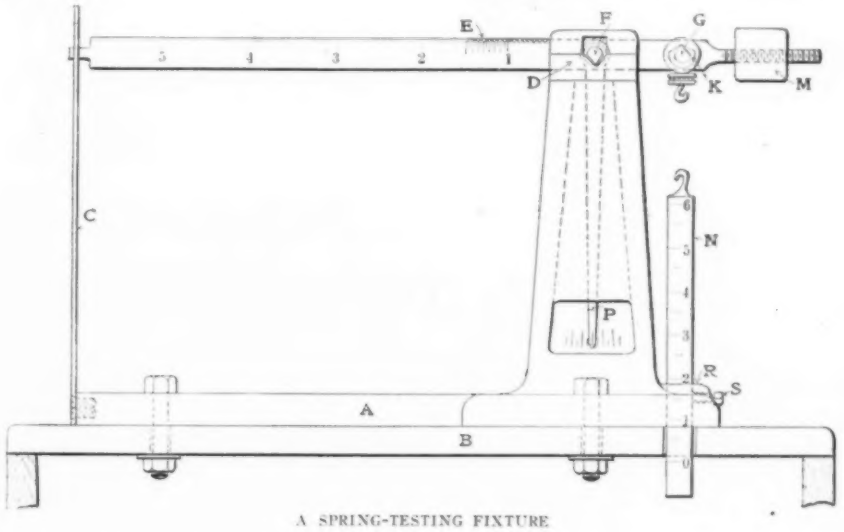
Of course if I had known that the whole thing was embraced in the formula $a^2 + 2ab + b$ and that everybody knew what the formula meant and could solve the problem in his head and say 42¼ just as quickly as he could do it my way, then I would have done him the same service. But suppose he did not know what the formula meant, then was it of any advantage to him? Or to put it another way, ought he to know the formula, or never want to square fractional numbers?

It is not to be expected that all others are to use a man's ideas; but if no one ever used another man's ideas, there would never have been but one smart

man—perhaps. Unless Mr. Hamilton invented $a^2 + 2ab + b^2$, he must be using some other man's idea; and maybe others are using his. JOHN E. SWEET.

A Spring-testing Fixture

Some little time ago, in the designing of some new movements for an intricate automatic machine, we wished to accurately test a number of springs. The end desired was to get a number of different springs which, on being stretched certain given distances, would give certain definite powers or pulls. Also a number of springs was often required of the same strength under the same tensional distance.



A SPRING-TESTING FIXTURE

The machine designed for this work has proved satisfactory and combines flexibility with accuracy to a surprising degree. The illustration does not pretend to be a fully detailed drawing, but it shows the working of the device. The following explanation will serve to make it clear.

The body casting *A*, which is held firmly on the box or table *B* by screws, bolts or other suitable means, has a round base with a square column projecting upward from its center and a long, flat leg carrying the guide strip *C*. On the top of the column at *D* are two V-blocks, one on each side of the balancing arm. They have 90-degree V's and are fastened to the top of the column with suitable screws and dowels. The balancing arm *E* pivots on the wedge-shaped block *F*, which rocks on the V-blocks at *D*. The wedge-shaped stud *G*, also carried in the balancing arm, holds the little yoke *K*. This yoke is really a ball-bearing swivel V-block, as it is fitted with a ball bearing to take care of any twist (torsionally) that may develop in the spring, either while it is being weighed or when first put into the machine. The short end of the balancing bar is threaded to accomodate the weight *M*, which is of course for adjustment in obtaining the exact balance of the arm when no load is being carried. The long end of the arm is graduated with 32 divisions or notches to each major division. The length of these divisions is equal to the distance of one pound from the center at *F* and also to the distance from this point to the center of *G*. Thus, as the size of the weights used ranged from 2 pounds to 1 ounce, the difference or change in the smaller springs could be measured down to 1/32 of an ounce. The hook bar *N* is made of such a length as to make the figures engraved on it, reading from the top of the boss *R*, show the amount of separation of the hooks. The bar may be graduated to any degree of fineness required.

For ease in telling when an accurate balance has been obtained, a pointer was fixed to the stud *F*, which could be read off on a dial inside the column through a glass, as shown. The column is cored out as indicated.

The spring to be weighed is placed over the hooks on *K* and *N*, the bar *N* having been set at the required distance by tightening the set-screw *S*. The weight (not shown) is then moved along the bar until the pointer rests at zero, when the pull necessary to extend the spring may be read off by the position of the weight on the balancing arm. The guide *C* has a vertical slot in which the end of the balancing arm runs, thereby preventing excessive movement. Of course the balancing arm can be made to any desired length, and the machine can be made to take care of all ordinary coiled springs.

M. R. KAVANAGH.

Multiple-drill Jig—Amusing Shop Experience

After a careful examination of the multiple-drill jig, shown on page 422 by J. H. Wood, I fail to see any valuable features in the device. Since the usual purpose of any jig or fixture is to produce duplicate parts with more or less speed and accuracy, with the employment of more or less unskilled labor, a near approach to a fool-proof device is desirable. In the jig shown, there is no guarantee that the bushings when set will prove to be exactly square with the base, and unless made extremely heavy they will certainly be distorted from the pressure of the wedges and screws.

The setting of the bushings is easily tampered with, and consequently there can be no confidence in the outcome, which will necessitate constant watching while in operation, as well as testing or resetting every time the jig is used. I think it would be found much more desirable, as well as cheaper in a jig of this kind, to insert the bushings in a plain cast-iron plate, thus insuring a permanent and accurate location of centers, making the location fool-proof as well as saving the time necessarily used for the constant testing and resetting, which would in the long run pay for several jigs. As a rule the employment of universal jigs with adjustable bushings in any form will usually be found to be an abomination, as there can be no confidence at any time in the accuracy of their setting, when subjected to rough usage.

The reading of the article by Ethan Viall, on page 414, relative to amusing shop experiences, recalls to mind an incident which occurred in the early part of my career. We were placing in position a retort in a packing house, under the personal direction of a contractor, who on this occasion wore a good suit of clothes and a high silk hat. Adjacent to the location of the retort was a convenient cross beam of a suitable hight to be conducive of "bumped heads." During the progress of the work, the contractor got under the beam, straightened up and drove the hat down over his eyes to an extent that required the combined efforts of two apprentice boys to effect its removal. I will admit, however, that the said apprentice boys were intensely interested in what was taking place and were not in a frame of mind conducive to any undue haste in effecting the removal of the hat.

H. D. PENNEY.

A Chinese paper, the *Schen-pau*, states that two officials named Li-pan-tsau and Schen-schau-hsün have been ordered to France to inspect places where cannons and other heavy war materials are made. They are to be followed soon by four more officials with similar duties, after which armories and factories are to be made in China along the lines of those visited and inspected.

An excellent self-lubricating, non-shrinking packing for a high-pressure steam, hot water locomotive and stationary engine throttle valves, should be made of twisted strands of pure asbestos, braided and combined with water-proofing material, vulcanized and coated with plumbago.

AMERICAN MACHINIST

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Is the Inverted-V Type of Lathe Bed All Wrong?

It seems to be settled that the Englishman will not see anything good in the inverted-V type of lathe bed as commonly made in this country. The merits of the flat *versus* the V-top type of bed have been discussed pro and con for forty years, but we do not recall seeing any such wholesale condemnation of American practice as the one which we find in a recent chapter of a valuable series of articles on machine-tool design which is now running in the *Engineer*, from the pen of Professor Nicolson, whose name is well known to our readers as the author of the celebrated Manchester experiments on high-speed steel.

The professor begins his discussion by the statement that the inverted-V bed "is an early type of bed discarded in this country [England] and often called the American bed." He follows this with his statement that "with the exception of William Sellers & Co., the inverted V is as exclusively used in America as the flat way is in Britain." In this latter supposed statement of fact he is wrong, as the flat-top bed is and for many years has been used by other American builders beside William Sellers & Co., for lathes of large size—his statement being substantially true as applied to small and medium-sized lathes, but very far from true as applied to large ones.

The extent of his condemnation of the V bed may be gathered from a few quotations: "It is easy to prove mathematically that wear must take place at about *ten to twelve times the rate* with the inverted-V guides that it will with flat-top guides." He then disposes of the claim that the V type is superior because of its freedom to adapt itself to the bed and indulges in some fine sarcasm at the same time by saying: "It will therefore be very necessary that the V type of saddle should be 'free to adapt itself to its bed!'" and he finally sums up his contention and delivers himself of more sarcasm by saying that "The only valid argument in favor of inverted V's is in our opinion *that the operator cannot sit upon them!* It occurs to us, however, to suggest that this might be obviated in the case of flat-top guides by supplying wooden boards armed with Swedish nails inverted and insisting upon their being kept upon the flat bed. Taken all in all, the inverted V's appear to us to be one of the crudest and most imperfect devices yet applied to machine tools."

Here, certainly, is a sufficiently pronounced condemnation to call for an answer. Passing by the general capacity of American lathe builders and their ability to discriminate between a good and a poor thing when the ratio between them is ten or twelve to one, we have the further fact that among such builders are several who are of English origin and who were raised upon the English bed, but who persistently continue to manufacture the American type. It seems to us that when their practice is assailed in this manner, it is for them to prove the reason for the faith that is within them.

The American Boy and His British Cousin

Again there is sad news for the American boy and his friends, according to a special cable despatch in the Sunday *Sun*. From this despatch we learn that an American millionaire manufacturer in an interview in London stated that he was going to take a number of English boys back to America with him and teach them the nail-making business in his factories, it being his belief (so runs the interview) that the English youth when properly trained, makes a more efficient mechanic than the American boy. Says this "millionaire manufacturer":

"There can be no question about English boys being superior to their American cousins from the standpoint of willingness to work and to remain at one trade. In learning a given trade they master every detail and turn out to be reliable men in whom employers can have every confidence.

"The American boy has no intention of working hard, at any rate for any length of time. He wants to get rich quick. He has not the patience, perseverance and pluck of John Bull, Jr. He looks for a new job every few weeks, aiming always to find one with the minimum labor for the maximum wage. He has no desire to earn his livelihood by the sweat of his brow, but seeks a junior clerkship, preferably in the offices of insurance companies or in law offices and banks."

It is quite unnecessary for us to characterize the foregoing as sheer rot; it will be recognized as such by all who read it, and by the English boy himself, quite as readily as by his cousins on this side of the Atlantic. There are all kinds of boys in America, and just as many varieties in Great Britain. Of those of either nationality who enter machine shops and other manufactories, some will develop into skilled men and others will prove failures, a situation which is common to all lines of occupation whether mechanical or not. That the American boy in the shop is a specialist at dodging hard work and lacks the qualities of patience, perseverance, and pluck, will be denied, we believe, as cheerfully by his foreign cousins who have worked with him, as by his American associates. We believe, also, that his opportunities and willingness to master the details of his trade are quite as pronounced as are those of the boys of any nationality. That he is given, as a class, to seeking such openings as a

"junior clerkship" (whatever that may be) may also be safely denied we think.

Is it possible that someone has been "stuffing" the *Sun's* London correspondent?

Does It Pay to Write?

On page 384 we gave a few suggestions on this topic and illustrated our remarks by one or two specific cases. Since then another one has come to our notice of a somewhat similar nature. The facts are as follows: In the year 1897 an article was contributed to the journal of the Franklin Institute, which appeared in the February number. On February 15 the New York *Sun* reprinted this article in full, with impressive headlines. On the same day one of the foremost newspapers of Philadelphia copied the *Sun's* reprint in full, headlines and all. On the following morning the author received a request from one of the dailies of Philadelphia to contribute editorial articles on industrial, economic and scientific subjects. No restrictions were placed on the length of articles, the time of delivery, nor subject, except that they should fall in the general classes mentioned. As the proposition did not interfere in any way with the author's regular work, he accepted it tentatively, and his first editorial was printed on February 9, 1897. This connection continued for a period of a little over two years, during which time 768 editorials on a wide range of topics were printed. In one year the emolument exceeded $2000, and all the editorials were written in spare moments, usually in the evenings. Many letters of commendation were received by the author, and a large number of the editorials were reprinted in technical magazines.

This is but another instance which proves that it does pay to write, and the fact may be of more interest to the readers of the AMERICAN MACHINIST when we state that the author to whom we have referred was and is connected with one of the largest machine-tool builders of this country.

The Technical Publicity Association

The Technical Publicity Association devoted the first meeting of the year, September 26, to the consideration of "The Mailing List." N. W. Gage, of the *Buyers' Reference*, and Burdette Phillips, of the *Central Station List and Electric Railway Directory*, addressed the association, and a long discussion followed in which various members told their experiences in making and using mailing lists, and in some instances compared this form of advertising with trade-magazine advertising.

It was decided to take up other phases of this broad subject at the October meeting of the association.

The Accuracy of Pressure Gages

Some highly interesting tests of pressure gages were recently made at the British National Physical Laboratory at the instance of the Manchester Steam Users' Association. For some unexplained reason the gages tested, instead of being collected in the open market, under which circumstances they would have fairly represented commercial gages, were supplied by the makers for the purpose of the tests, and hence they doubtless represent superior and perhaps the best obtainable instruments. At the same time, they show what is possible with gages of the usual Bourdon spring type and as far as they go, the results are eminently satisfactory.

A total of ten gages was subjected to quite exhaustive tests, of which there were several series. The first series compared the readings of the gages with a standard mercury column, and in this series the extreme error found in the entire lot was less than one pound per square inch in gages running up to readings of 200, 250 and 300 pounds, this error being, in the case of seven of the ten gages, uniformly on the safe side—that is, the readings being a trifle high.

The second series of tests was intended to develop the effect of temperature on the gages, which were inclosed in a heated chamber maintained at a temperature of 150 F. Under these tests the gages were found to read uniformly high, the error increasing with the pressure to a maximum of between 5 and 6 pounds at the limit of the scale. In view of the fact that many gages work in an elevated temperature, our contemporary *Engineering*, from which we obtained our information, suggests that the high reading of a hot gage may very often have been responsible for an apparently excessive drop of pressure between boiler and cylinder—a circumstance that could not be detected by reversing the gages at the two ends of the pipe, as the conditions of temperature would be reversed with the reversal of the gages.

The third set of tests related to the effects of vibration, an apparatus having been made by which the gages were vibrated as many as 725 times per minute through a distance of 1/10 inch, and also through larger distances, but under a diminished number of vibrations. Some of the gages had the rack, tube and hand balanced in order to offset the effect of vibration, and with these gages the vibration was found to produce no disturbance of the reading whatever. Ordinary gages vibrated widely in this test.

With the completion of the vibration tests the gages were subjected to additional tests in order to determine the injury, if any, which had been caused by the severe usage, and also in order to determine the effect of back lash and friction of the mechanism. It was found that the mean readings of the instruments agreed closely with the first readings taken, showing that the gages had not been injured by the temperature and vibration tests. In order to determine the effect of lost motion and friction, the readings were taken with a slowly increasing and slowly decreasing pressure, the result being that in the worst case the error due to friction and back lash never equalled one pound.

The testing of gages as they are found in use is very commonly done by the inspectors of boiler insurance companies, and while the highly refined tests referred to above are eminently satisfactory as far as they go, it would be much more important to know how ordinary commercial gages behave under test, and especially to know how well they maintain their accuracy with lapse of time. An attempt at the determination of this point was made in connection with these tests by maintaining full pressure on the gages for a period of 24 hours without finding an appreciable error due to the continued pressure, but obviously this is a very insufficient test and not to be compared with what might be obtained by analyzing the records of boiler insurance inspectors.

The average man has a touching degree of faith in the accuracy of a steam gage. He will buy the cheapest instrument which he can find, and use it for an indefinite period without questioning its readings for a moment. The subject is certainly one of importance, and boiler insurance companies have no doubt a collection of data which, properly collected and arranged, would supply some much needed information.

New Publications

STANDARD POLYPHASE APPARATUS AND SYSTEMS. By M. A. Oudin. Fifth Revised and Enlarged Edition; 369 5½x7¾ inch pages, with 207 illustrations. The D. Van Nostrand Company, New York. Sampson, Low, Marston & Company, London. Price, $3.

That this book has met a real want is sufficiently shown by the appearance of the fifth edition since the first publication eight years ago. The present edition has been revised and brought up to date, and is a thoroughly useful manual of the actual working of the several polyphase systems now sanctioned by the best practice. It is intended for those who operate or are interested in, rather than those who design polyphase machinery, and consequently is entirely non-mathematical. It goes into the characteristics and actions of polyphase apparatus in a manner to explain its principles and properties, and to enable the reader to acquire an intelligent understanding of it, and it does this with a degree of fullness which will enable those whose experience has been confined to direct-current machinery to read and understand it.

New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A Handy Portable Grinder

The uses of flexible shafting are many and varied, from the driving of the dentist's instrument of torture up to heavy grinding and power transmissions.

One of the neatest applications is in connection with a little portable grinder made by the Coates Clipper Manufacturing Company, of Worcester, Mass., which also makes the shafting that drives it.

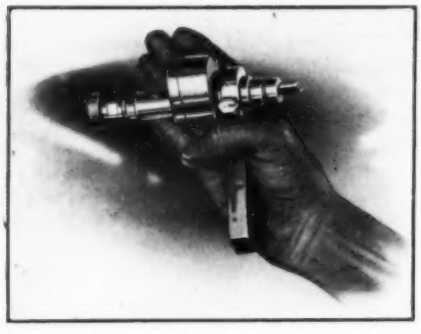


FIG. 1. THE GRINDING ATTACHMENT

It is called the Flexible Speed Multiplying Grinder, because the grinder head contains multiplying gears which run in oil and increase the speed 8½ times; so that with a motor running 2500, you get 21,000 turns a minute at your grinding wheel. The grinder is so small it will go in the tool post, as shown, or can be held in the hand for finishing up metal patterns, cleaning up cast gear teeth or for finishing up drop-forging and other dies. In all of this work the grinder is carried right to the piece to be ground, so that dies do not have to be removed to grind out wrinkles, which sometimes occur, and a lot of time is saved.

The grinder is run either by an electric motor on the other end of the flexible shaft, by rope drive or in any other way; but the multiplying device enables a high surface speed with a small wheel and enables work to be done very rapidly.

The illustrations give an idea as to the size of the tool and some of its uses. Others will suggest themselves, such as center grinding by using in the tool post with a compound rest. Conditions will determine what motive power it is best to use.

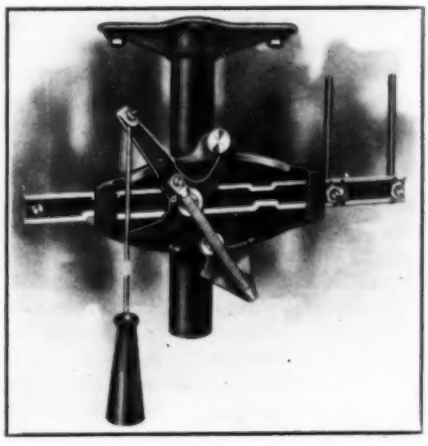
Electric motor outfits are furnished for direct current from 110 to 500 volts and for 110 volts alternating, either having advantages over any other form of drive in most cases.

There are many places where an outfit of this kind will save its cost in a very short time. By its use a very efficient cutting speed is obtained from wheels one inch in diameter and even smaller.

A Belt Shifter

By means of the belt shifter illustrated, a machine is either started or stopped by a pull on the handle attached to a single line (Samson Spot Cord is usually furnished), which may be located in a position most convenient to the work. The parts, with the exception of the support and base-plate, are of pressed steel. The shifter is clamped to a pipe screwed into a ceiling flange, and is adjustable from 5 to 16 inches from the ceiling.

The action of the mechanism is as follows: The sliding bar which carries the shifter fingers has mounted upon it a lever or double bell crank; to the end of its long arm the pull cord is connected, and at a point nearer the center there is a pin acted upon by a compression spring which keeps the bell crank in its normal position and also locks the shifter bar at the ends of the stroke. The tendency is for the center line of the spring to maintain a position intersecting the axis of the



A BELT SHIFTER

bell-crank fulcrum pin. Assuming that the device is in the position shown in the cut, with one wing of the bell crank engaging on the upper pin fixed in the base-plate, the effect of a pull on the cord is first to draw down the shifter bar so that the left-hand notch is disengaged from the lug on the casting, leaving the bar free to move; the wing of the bell crank acts on

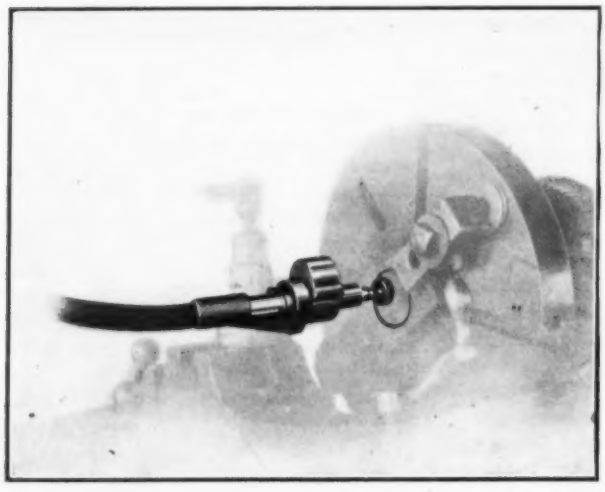


FIG. 2. USED IN THE TOOL POST

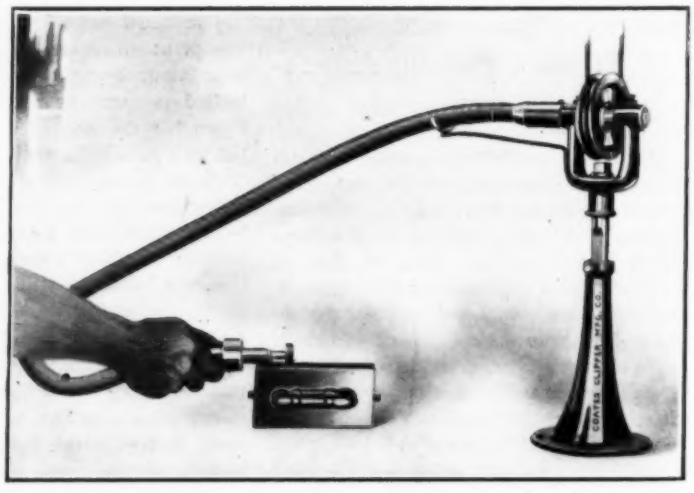
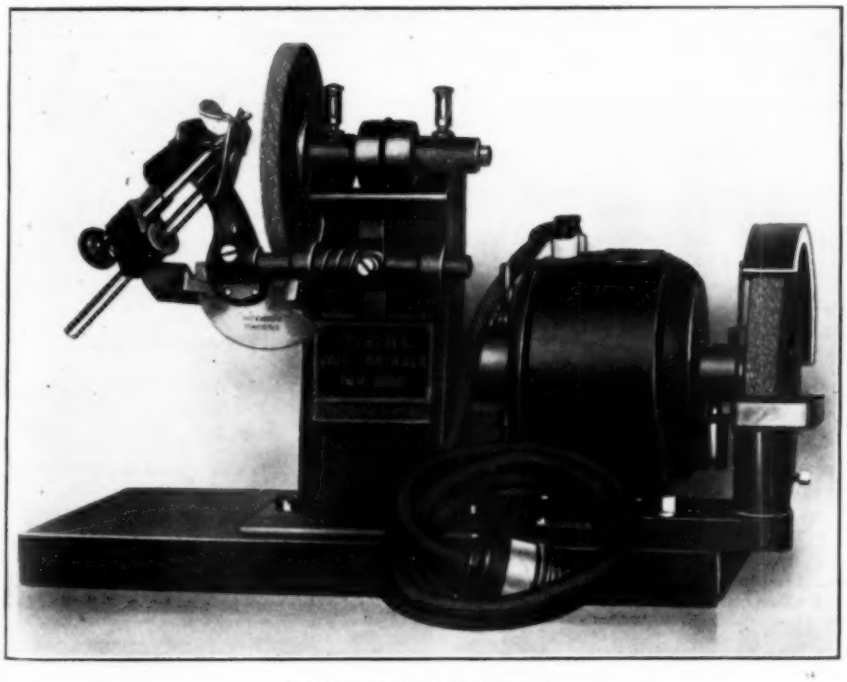


FIG. 3. USED ON DIE WORK ON THE BENCH

the fixed pin as a fulcrum to move the bar to the right, the center of rotation of the bell crank moves over to the right of a vertical center line and the spring throws the bell crank to a position the reverse of that shown, ready to be shifted back by another pull on the cord; the notch at the right-hand end of the sliding bar engages with the lug on the base-plate casting, locking the bar in position. It will be noted that on the lower edge of the sliding bar are two stop notches spaced farther apart than those on the upper edge. As sent out, the shifters are adjusted for 2-inch belt, but to adapt them to 1½-inch belt, the sliding bar is turned over to bring the other notches into action. The fork fingers, as well as the sliding bar, are reversible, and the former are adjustable in position. The base-plate may be clamped upside down if desired, and the cord run upward, over pulleys, and to any desired point. The "Pullet" belt shifter is made by the L. & D. Company, 88 Broad Street, Boston, Mass.

Small Twist-drill Grinder

The small grinder shown by the half-tone is driven by a motor which will operate from a lamp socket, and has, besides the drill-grinder wheel, a 6x¾-inch emery wheel which may be used for tool sharpening or any light grinding. It also accommodates those men who are sometimes found that prefer to hold a drill in



SMALL TWIST DRILL GRINDER

their hands and grind it on an ordinary wheel.

The smaller size grinds from No. 70 to ⅜-inch drills, and the larger grinds from No. 70 to ½-inch; these grinders can also be obtained for belt drive, and an attachment for cutter grinding may be furnished. If not desired for mounting on a bench, an iron pedestal may be had. The drill holder has steel fingers which enter the grooves of the drill and hold it firmly at the point, and the setting of the shank gives the proper cone and clearance. This tool may be obtained from A. N. Frecker, Inc., 95 Liberty street, New York City.

A Universal Joint

Fig. 1 is a side view and a cross-section through the pivots of the joint. *F* and *F'* are the forks, *C* is the center block, *P* the pin, and *S* are the two screws, set up against the pin to hold it in position and keep the parts assembled. The pin and the screws are the pivots of the joint. Six pieces, quite plain in shape but requiring fine workmanship in their make-up, constitute the whole joint.

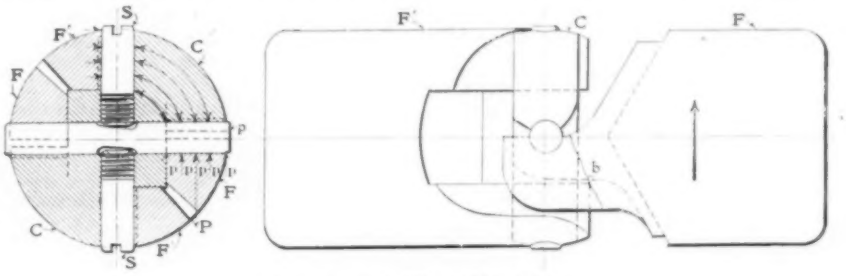


FIG. 1. THE UNIVERSAL JOINT

As will be understood, the pin and the screws are backed up by the center block and are therefore subject to neither bending nor shearing strains but merely compression transversely. The actionary and reactionary forces, set up in the joint in transmitting the power, are directly opposing or balancing each other and also applied at the periphery of the joint, giving to them the largest possible leverage. Fig. 2 shows the joint assembled and disassembled. When run in one direction, the pressure comes on the pins; but in the other direction the pressure is upon the flat surfaces. These joints are therefore made for right- or left-hand drives, by John H. Montstream, Hartford, Connecticut.

Too many engineers work by rule instead of reason; on routine plans they "turn out the work," make money for the stockholders and lead in the race for promotion to the desk of Chief Engineer, while the plodder, who takes time to reason and profers to be right and safe at all costs to being president of the company, remains at the board in the room upstairs. With the "rusher" in the chief's chair to dictate the designs and the "ruler" in the computation room, the special designs get scant consideration, and such results as the Big Warrior, Cincinnati and Quebec bridges may be expected—James W. Pearl in *Engineering News*.

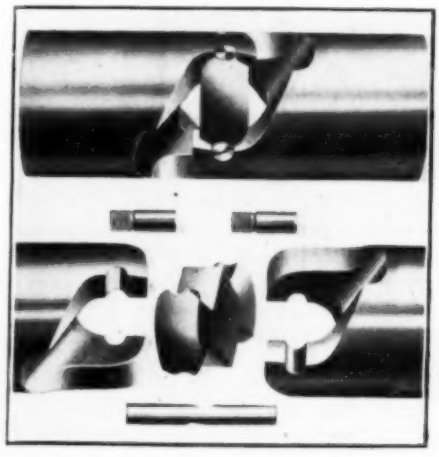


FIG. 2. THE JOINT ASSEMBLED AND DISASSEMBLED

All of which can well be applied to other work besides bridge-building.

The Navy Department is preparing for a comparative demonstration of the steam turbine and the reciprocating engine as well as a comparison of the two types of steam turbines.

A patent process called "sheradizing" is reported to make iron and steel rust proof, and besides coating iron and steel better than the ordinary wet galvanizing method it has the added advantage of being capable of being brilliantly polished. In the process zinc dust is placed in a cylinder which has been brought to a temperature of 400 to 500 degrees Fahrenheit; that is, below the melting point of zinc. The articles it is desired to "sheradize" are put into the cylinder, which is then revolved. The zinc in this process is not actually melted, but forms an alloy through the surface of the articles absorbing the zinc, and then a coating covering the whole visible surface is deposited to any desirable thickness. Articles thus treated are said to have an even and adherent coating which wears excellently and does not strip, and that by the use of a lime mop are easily polished. It had been found that the use of the wet galvanizing process upon articles on which threads are cut made it necessary afterwards to recut the threads. This, it is claimed, is obviated in the new process, thus avoiding both the additional work of recutting the threads and also making the threads themselves rust proof. Another advantage claimed is that because articles are not heated to a high temperature the temper of the steel is little affected, while its tensile strength and that of iron remains the same.

Personal

S. H. Bullard, vice-president and sales manager of the Bullard Machine Tool Company, Bridgeport, Conn., sailed on October 3 for an extended business trip to Europe.

Louis H. Morgan, recently manager of the Ridgway Machine Company, and formerly superintendent of the Pond plant of the Niles-Bement-Pond Company, is now connected with the Vandyck Churchill Company, of New York, Philadelphia and Pittsburg.

Business Items

The Hess-Bright Manufacturing Company, Philadelphia, Penn., has opened an office at 1313 West Street building. R. D. Macdonald, manager.

The Ridgway (Penn.) Dynamo and Engine Company, has reopened its Chicago sales office at 824 Marquette building. F. S. Hickok is in charge as manager.

The Watson Machine and Tool Company, Bethel, Vt., has been incorporated for the purpose of perfecting inventions, designing and manufacturing automatic machinery.

The Vandyck Churchill Company, of New York, Philadelphia and Pittsburg, has concluded an arrangement whereby it will represent the Cleveland Crane and Car Company, exclusively in the New York and Philadelphia territory.

The Standard Roller Bearing Company, of Philadelphia, Penn., has increased its capital of $3,500,000 to $5,000,000. Large additions are now being made to the plant and equipment for the purpose of enlarging its department for the manufacture of roller bearings for shafting hangers and also for the establishment of an entirely new department for the manufacture of roller bearings for trolley cars.

Trade Catalogs

Wile Power Gas Company, Rochester, N. Y. Catalog describing suction gas producers. Illustrated, 20 pages, 6x9 inches, paper.

The Heald Machine Company, Worcester, Mass. Catalog of cylinder and surface grinder. Illustrated, 24 pages, 6x9 inches, paper.

The L. & D. Company, 624 Broadway Exchange building, Boston, Mass. Circular illustrating and describing the "Pullet" belt shifter.

The Henry & Wright Manufacturing Company, Hartford, Conn. Catalog of ball bearing drill presses. Illustrated, 54 pages, 6½x8½ inches, paper.

The E. F. Reece Company, Greenfield, Mass. Catalog No. 6, describing screw cutting tools and machinery. Illustrated, 82 pages, 4½x7 inches, paper.

The Adjustable Collet Company, Cleveland, Ohio. Pamphlet describing A. C. combination drill chuck and adjustable collet chuck. Illustrated, 4 pages, 6x9 inches.

Manufacturers

The Berkley (Va.) Ice Works will build a 50-ton ice plant to replace one recently burned.

Alfred C. Haines, Philadelphia, Penn., glass manufacturer, will erect a new $50,000 factory.

The plant of the Diamond Match Company, at Lyonsville, Cal., recently burned, will be rebuilt.

The plant of the Atwater-Nelson Buggy Company, Thomaston, Ga., was destroyed by fire. It will be rebuilt.

The City Ice Company, Cuero, Texas, recently incorporated, will erect and equip buildings at a cost of $12,000.

The plant of the Standard Cordage Company, of New York, at Chelsea, Mass., was burned, causing a loss of about $40,000.

The National-Acme Manufacturing Company, Cleveland, Ohio, building screw machines, is erecting an addition to its plant.

The Greenfield (Mass.) Light and Power Company has awarded a contract at Deerfield River for an electric power plant to cost about $10,000.

The Nashville, Chattanooga & St. Louis Railway has awarded contract for the erection of roundhouse and machine shop at Bon Air, Tenn.

The De Vilbris Plier Company, Dundee, Mich., has been organized to manufacture patent pliers. Capital, $100,000; president, F. W. Gradolph.

The Rochester (Minn.) Pump Company is being formed with a capital of $50,000. J. J. Reiter, John W. Hendricks, William Enke, etc., are incorporators.

The Patton Vacuum Evaporator Company, of Springdale, Ark., has filed articles of incorporation. The capital is $150,000. William J. Patton, president.

The Missouri, Kansas & Texas Railway will erect car buildings, shops, roundhouse, etc., at Smithville, Texas. J. W. Petheram, Dallas, Texas, chief engineer.

The Gulf, Colorado & Sante Fe Railway will erect shops, roundhouse and depot at San Augustine, Texas. C. F. W. Felt, Galveston, Texas, is chief engineer.

The Princeton (W. Va.) Power Company, lately incorporated, will establish an electric power plant at a cost of $25,000. S. J. Evans, president and general manager.

The Lake Shore Canning Company, has been organized at Sheboygan, Wis., and a plant will be erected at Sheyboygan Falls. Herman Schreier, of Sheboygan, is at the head of the company.

The Nelson Manufacturing Company, Willmar, Minn., has been incorporated with a capital of $600,000. A plant for the manufacture of hay stackers, gasoline engines, automobiles, etc., will be erected.

The Blue Ridge Bending Company, Lenoir, N. C., recently incorporated, will erect a plant for the manufacture of bent rims for wagons, carriages, farm implements, etc. J. R. Powell is manager.

The Lexington (Tenn.) Machine Works has been incorporated with $15,000 capital stock to operate general repair shop and build steam engines. Incorporators, H. E. Graper, W. T. Watson, etc.

The Michigan Motor Castings Company has been organized at Flint, Mich. as a branch of the Detaroit Stoker and Foundry Company. A building for the manufacture of automobile castings will be erected.

The Aden Axle Lubricating Company, has been incorporated at Greensboro, N. C., to manufacture a device for lubricating buggy axles. Capital, $25,000. C. M. Vanstory, president, Joseph Aden, general manager.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G. Smith Co., Columbia, Pa.

Clockwork. Larchmont Mfg. Co., Larchmont, N. Y.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Want to buy a screw cutting engine lathe at once, 2680 E. 61st St., Cleveland, Ohio.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Automatic and special machines designed. E. A. Johnson Co., 28 Second Pl., Brooklyn, N. Y.

Special machinery and manufacturing plants. Albert Pott M. E., 23 Platt St., New York.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Orders in quantities for brass castings from ¼ to 2 lbs. in weight. Box 454, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—Energetic steel or machinery salesman as manufacturing partner in central States. Box 497, AMERICAN MACHINIST.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Multiple drill for drilling flanged fittings and flanges; 10-ton traveling crane, 32 ft. span; tapping machine for pipe fittings and flanges. Materne Mfg. Co., St. Louis, Mo.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if its "right." Roy Machinery Co., Minneapolis, Minn.

Apprentices and others wanting to pass examinations as licensed engineers need Tuley's Handbook on Engineering. A library in one volume of 1000 pages, $3.50. Hill Publishing Co., 505 Pearl St., New York.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Investments that pay, the books that give you more knowledge than your job requires; we can tell you the ones you need if you tell us your specialty; send for our 168-page catalog. Hill Publishing Co., 505 Pearl St., N. Y.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Wanted—High-grade machine work, especially for screw machines and turret lathes. We can refer to a very well known line of high-grade tools now on the market to demonstrate that we are able to do the highest grade of interchangeable work. Box 386, AMERICAN MACHINIST.

Arrange with us to do your manufacturing; we are thoroughly equipped for all class of machine work, including screw machines and punch parts, tools, jigs, etc; we design and build special and experimental machinery, also automobile and marine gasolene engines. Forest City Specialty Manufacturing Co., of Rockford, Ill.

For Rent at Yonkers—A 3-story factory located 300 ft. from New York Central depot and 600 ft. from Hudson River boat landing. Building in perfect condition with complete equipment of drive shafting, 40 H. P. Engine, 80 H. P. Boiler and Dynamo for complete lighting. Floor space 13,000 sq. ft., together with 2300 sq. ft. of yard room. Two large fire-proof vaults in offices. Box 393, Yonkers, N. Y.

Wanted—An interest in a small or moderate sized machine shop, by a gentleman having a general knowledge of the business and who will have a small amount of machinery of rather high grade to build; buildings must be of recent construction, detached and having considerable vacant land for future extensions; tools and equipment must be fairly modern; location on some main line of railroad preferred; must be in a good labor market; all communications must be considered confidential by both parties. Box 464, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Position as superintendent or mechanical engineer; fine experience; up-to-date; knows methods from A to Z. Box 496, AMERICAN MACHINIST.

COLORADO

An experienced, result producing sales manager now satisfactorily employed except as to location, solicits correspondence with well organized Eastern manufacturing company making high-grade machinery that can offer responsible, executive position; is experienced factory accountant, also has good working knowledge electricity, mechanics, and mining machinery; welcomes investigation record for intelligence, ability and integrity. Box 483, AMERICAN MACHINIST.

GEORGIA

Position as superintendent or general foreman on electrical apparatus; special machinery, or general machine work. Box 465, AMERICAN MACHINIST.

ILLINOIS

Mechanical and electrical draftsman; technical graduate; 5 years' shop, 5 years' office experience in designing special machinery, tools, fixtures, jigs, controllers and circuit breakers; wishes steady position; A-1 references. Box 491, AMERICAN MACHINIST.

INDIANA

General foreman desires to change position; experienced in designing. Box 488, AMERICAN MACHINIST.

MICHIGAN

American, mechanical engineer, twenty-nine, seven years' experience on machine tools and hoisting machinery, wishes to change; location preferred, New York or Pennsylvania. Box 481, AMER. MACHINIST.

NEW JERSEY

Automatic and special machinery designer; age 36; 20 years' shop and drafting room experience; first-class ability; salary $2000; at liberty Dec. 1. Box 489, AMER. MACH.

NEW YORK

Mechanical draftsman wishes position. Box 499, AMERICAN MACHINIST.

Mechanical draftsman; experienced on the design of general machinery; technical man with shop experience. Box 495, AM. MACH.

Draftsman, practical man, 30 years of age with experience on fine machinery desires position; technical graduate. Box 471, AMERICAN MACHINIST.

Superintendent or general foreman for light, interchangeable work; resourceful; wide experience; gilt edge references. Box 478, AMERICAN MACHINIST.

Position wanted by expert tool and instrument maker; age 35; electrical, scientific instruments or experimental work; any location. Box 493, AMERICAN MACHINIST.

Man of ability, with technical training and experience in mechanical, electrical and commercial work, wishes permanent connection with reputable concern in New York City as secretary or manager. Box 479, AM. MACH.

Superintendent or assistant technical graduate; age 30; 7 years' experience as machinist and toolmaker; 4 years as designer of special machinery, tools, fixtures, etc.; at present in charge of drafting room. Box 494, AMERICAN MACHINIST.

Young man, one of my most reliable; 20 years old; graduate from Baron de Hirsch trade school; four years' practical experience as foreman of chuck department, desires to return to New York City; and I am anxious to secure him a suitable position. Address "Errington," 39 Cortlandt St., New York. Telephone 3140 Cortlandt.

PENNSYLVANIA

Mechanical draftsman wants position with firm needing experienced man. Box 492, AMERICAN MACHINIST.

RHODE ISLAND

Draftsman, 27, wants position; wide experience on automatic and special machinery, tools, etc.; 4 years' shop and foundry, 11 years drafting; excellent references. Box 498, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—Machinists; one Jones & Lamson screw machine operator, two boring mill, two planer hands and two fitters; steady work and good wages to first-class men. Farrel Foundry & Machine Co., Ansonia, Ct.

ILLINOIS

Wanted—A first-class patent draftsman; one having had experience in mechanical drafting preferred; in replying, give age, nationality, salary expected, experience and references. Box 490, AMER. MACHINIST.

Wanted—A man of good shop and executive experience, preferably in the manufacture of electrical machinery, to take charge of the inspection department of an electrical company; state fully experience, age and salary expected. Box 482, AMER. MACH.

Wanted—Superintendent for factory employing seventy-five to one hundred men; must be practical mechanic with executive ability, able to reduce cost to minimum and install piece work; permanent position to right man; give age, experience, reference and salary expected. Box 460, AMER. MACH.

INDIANA

Wanted—First-class blacksmiths in wagon department; give experience and wages wanted, with application. Address Supt. Wagon Dept., Studebaker Bros. Mfg. Co., South Bend, Ind.

Wanted—First-class foreman thoroughly versed on die and machine work, such as bulldozers, drop and trip hammers, punch, shear and trimming machines of all kinds, also forging machines, to forge and shape irons for farm wagon gears; state age and experience. Address Supt. Wagon Dept., Studebaker Bros. Mfg. Co., South Bend, Ind.

KENTUCKY

Wanted—Business manager for machine shop, representing an investment of $100,000 in a city of 175,000 inhabitants, located in Ohio; desire man who can invest $10,000. Address, with references, "Manager," Box 442, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Operators on Gleason gear planers. Boston Gear Wks., Norfolk Downs, Mass.

MICHIGAN

Owing to increasing business we are constantly in need of first-class machinists both for floor work and tools, also first-class molders. For further particulars address Wm. E. Hill & Co., Kalamazoo, Michigan.

NEW JERSEY

Toolmaker wanted; must be accustomed to die work. Votey Organ Co., Garwood, N. J.

Wanted—An assistant mechanical engineer for a large textile plant; technical graduate with shop experience, preferred; age 25 to 30; good salary to the right man. Box 474, AMERICAN MACHINIST.

NEW YORK

Wanted—Competent machinist foreman for shop doing general business in new machinery and repairs. Box 477, AMER. MACHINIST

Wanted—Draftsman familiar with steam pumps, air compressors and steam engines and acquainted with best American practice; mechanical engineer who has had shop experience preferred; location of works, New York city. Address stating age, experience and salary desired. "S. P. W.," AM. MACH.

OHIO

Wanted—Draftsman, experienced on heavy machine tools, particularly boring mills above six feet; give experiences and salary wanted. Box 384, AMERICAN MACHINIST.

Wanted—First-class foundry superintendent for machine molding grey iron foundry of 50 tons capacity; the foundry is equipped in a strictly up-to-date manner; no hand molding; only green men employed; applicant must be strictly temperate in habits, of good character, aggressive and must possess an abundance of executive ability; full knowledge of all molding machines and best application of patterns is absolutely necessary; give full particulars and references; no cheap man need apply. Box 376, AM. M.

PENNSYLVANIA

Wanted—An experienced molder, familiar with cylinder work; give full details of experience and wages. The Shepherd Engineering Co., Williamsport, Pa.

Mechanical draftsman and designer, with practical machine shop experience for designing automatic machinery; one acquainted with rotary envelope machinery preferred. Box 480, AMERICAN MACHINIST.

We are increasing our capacity and invite applications from all classes of strictly first-class machinists; steady work, good wages, open shop, nine-hour day; no labor troubles. Riverside Engine Company, Oil City, Pa.

On account of increased business we are constantly in need of high-grade planer, lathe and boring mill hands; also competent erectors; no labor troubles. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Foreman machinist as partner in prosperous Pittsburg jobbing shop; dies, stamping and special machinery; good man given chance to work for me few months before investing; splendid opportunity for right man. Box 475, AMERICAN MACHINIST.

Wanted—First-class die maker, must be familiar with drawing and forming dies; one who is capable of taking charge of die makers, good chance for right man, steady work; give reference and state wages expected. Box 424, AMERICAN MACHINIST.

Wanted—A first-class man as general foreman of brass department, manufacturing a general line of steam cocks, such as brass globe and angle valves, gate valves, steam cocks, etc., works located Western Pennsylvania; state age and experience. Box 476, AMERICAN MACHINIST.

Several men familar with high-grade steam engines, for erecting and testing department of engine works, also for outside erecting and starting; to receive consideration, give duration and full details of past and present employment, compensation received, etc.; communications held confidential if desired. Box 458, AMER. MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

FOREIGN

Master mechanic; Swede; practical and thoroughly acquainted with modern machine shop practice and experienced in handling men, wanted at once for new shop in Sweden; one with experience from locomotive and iron works preferred; good chance for the right man; none but an energetic and fully competent man need apply. "Practical," AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

Nearly new bench lathe and tools. A. F. Wisner, 119 N. Norwood ave., Buffalo, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

Machine shop for sale; $3000 a year; owner died; big sacrifice for cash. Address Box 112, Georgetown, Colo.

One 2 in. Potter & Johnston semi-automatic turret lathe in A-1 condition; one 2¾ in. Cleveland plain automatic turret lathe in A-1 condition. Box 461, AMER. MACHINIST.

For Sale—Two No. 00, three No. 0, one No. 2 Brown & Sharpe second-hand automatic turret forming machines. Strong, Carlisle & Hammond Company, Cleveland, O.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

For Sale—The following new machinery, all in A-1 condition; 1 No. 3 Becker-Brainard vertical milling machine with rotary table, etc.; 1 Sibley & Ware power drill 20-inch table; stationary head, back geared, self feed, etc.; 1 Ferracute embossing press, class E, series E3, made by Ferracute Machine Co., of Bridgeport, N. J.; the above is offered on account of being too large and heavy for our work. Write or call and see it. Superior Seal and Stamp Co., 52 Woodward Ave., Detroit, Mich.

Steam engine for sale; 250 h.p. Greene automatic cut-off, double-crank, non condensing horizontal engine, size 16 inches by 42 inches, two cylinders, with band fly-wheel 14 ft. by 31 in., speed 75 r.p.m.; built by F. C. & A. E. Rowland, New Haven, Conn.; this engine is in excellent condition, and has been in regular service in our factory for several years, being displaced by electric equipment in the enlargement of our plant; it may be seen running until Oct. 5, its use being discontinued after that date. Winchester Repeating Arms Co., New Haven, Conn.

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Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Globe Machine & Stamping Co., Cleveland, O.
Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Walker, N. U., Boston, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cleveland Twist Drill Co., Cleveland, Ohio.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arches, Boiler Door

McLeod & Henry Co., Troy, N. Y.

Architects

Dodge & Day, Philadelphia, Pa.
Seaver, John W., Cleveland, O.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.

Bearings, Ball and Roller —*Continued.*

Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

See Hoists, Hand

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.
Witteman Co., A. P., Phila., Pa.

Blowers

American Blower Co., Detroit, Mich.
American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.

Blowers —*Continued.*

Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Boiler Setting

McLeod & Henry Co., Troy, N. Y.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.

Boring and Drilling Machines, Horizontal—*Cont.*

Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Buliard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Carr Bros., Syracuse, N. Y.
Fairbanks Co., Springfield, O.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction

Electric Controller & Supply Co., Cleveland, O.

Brazing

Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.

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Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels.

Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Berry & Parker, Erie, Pa.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Manufacturers Fdry. Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry. & Mach. Co., Ansonia, Conn
Kent & Co., Edwin R., Chicago, Ill
Keystone Steel Casting Co., Chester, Pa.
Witteman & Co., A. P., Phila., Pa.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D .E., New London, Conn.

Centers, Planer
Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.

Chucking Machines—*Cont.*
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Electric Controller & Supply Co., Cleveland, O.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring
Adjustable Collet Co., Cleveland, Ohio.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Brunswick Refrigerating Co., New Brunswick, N. J.
Seymour & Whitlock, Newark, N. J.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.

Countershafts—*Continued.*
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Electric Controller & Supply Co., Cleveland, O.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Crane Pullers
Walker, N. U., Boston, Mass.

Cranes
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

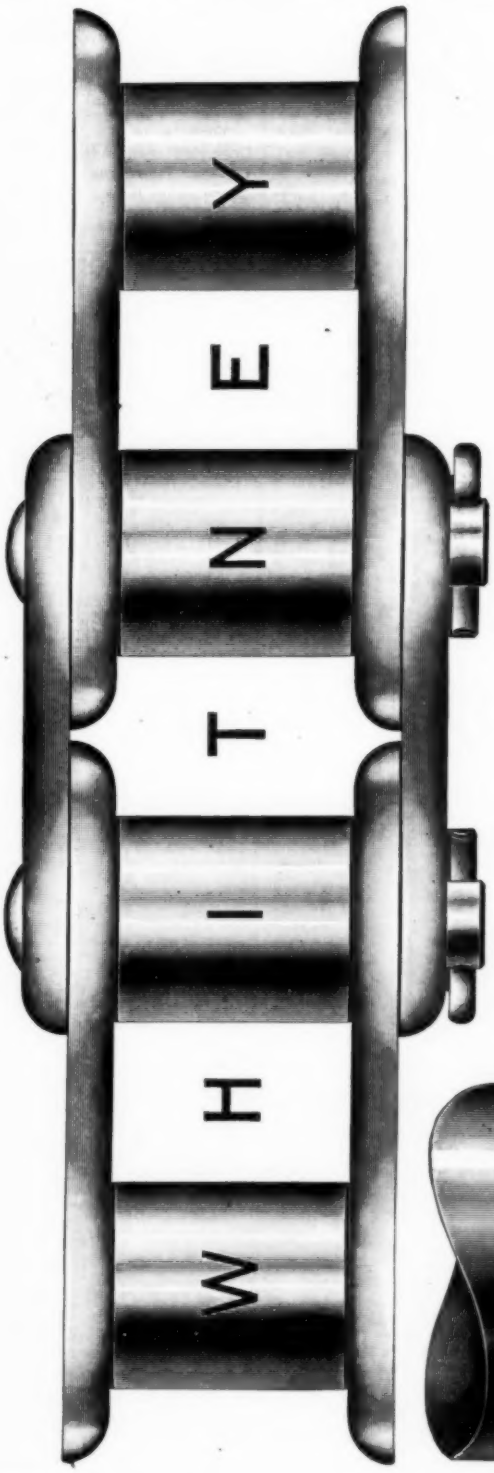
Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

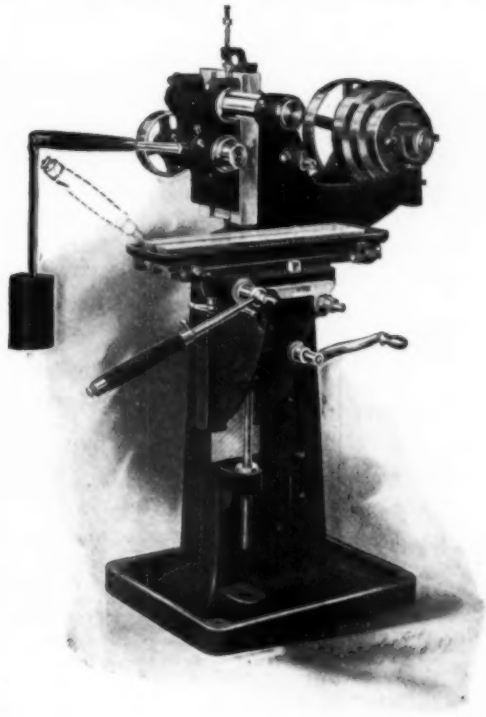
Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.

"WHITNEY" CHAINS

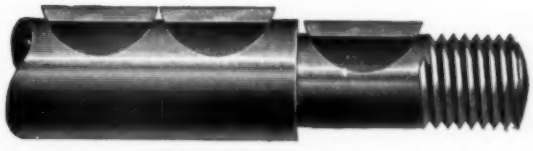
Hand (feed) Milling Machines

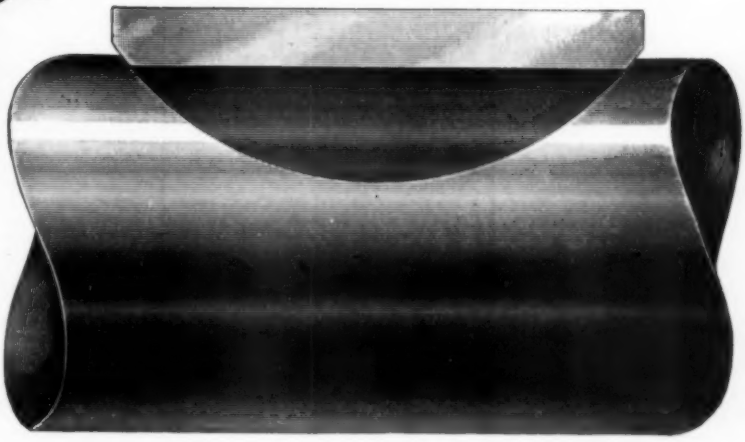
The Woodruff Patent System of Keying





The New Model.





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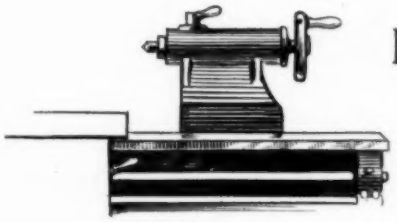

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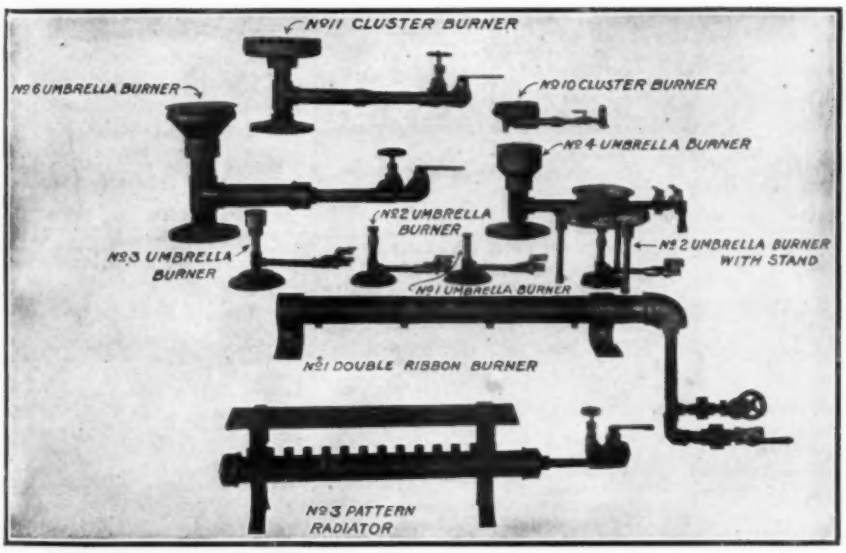

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Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
Morse, Williams & Co., Phila., Pa.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Perkins Mfg. Co., Springfield, Mass.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Carey, Samuel, Glendale, L. I.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets

Burke Electric Co., Erie, Pa.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.

Inspecting Tools with the Test Indicator*

How the Universal Indicator Is Utilized in the Toolmaking Department for the Inspection of Various Classes of Work

BY J. H. BOULET†

In the accompanying illustrations are shown a number of methods of testing and measuring various classes of tools by the aid of a universal test indicator. This instrument, which is a patented device manufactured by the writer, is shown in Fig. 1 with the different attachments required for indicating surfaces in various planes, reaching into small holes, testing the rear faces of work held in chucks, and for numerous other purposes. Of the two bars shown directly beneath the tool, the one with pointed end is for locating work by a center-punch mark, while the other is of service in testing the alinement of lathe centers, etc. The graduated plate at the end of the shank reads directly to thousandths of an inch.

Testing a Surface or Bed Plate

For testing the surface of a plate the indicator is mounted, as in Fig. 2, in an upright position on a surface gage fitted with an extension arm of about one-half the length of the plate to be tested. By placing the base of the surface gage at the center of the plate and reaching to its four corners, then reversing from each corner to the center, or by moving around the plate to any part of its surface and reversing the test at each time, the multiplied error (if any) will be plainly shown by the test indicator, as the extension arm on the surface gage is in this case six times longer than the base of the gage. It is necessary that the test indicator should give exactly the same reading when moving forward, backward or sideways on any ordinary test. The indicator shown will stand this test without variation in the reading. It will be noticed in the illustration that a cutter was slipped on to the tail end of the extension arm for a counterbalance.

Testing the Accuracy of an Angle Plate

Fig. 3 illustrates a method of testing an angle plate. It will be noticed that an ad-

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†Chief inspector, toolmaking department, United Shoe Machinery Company.

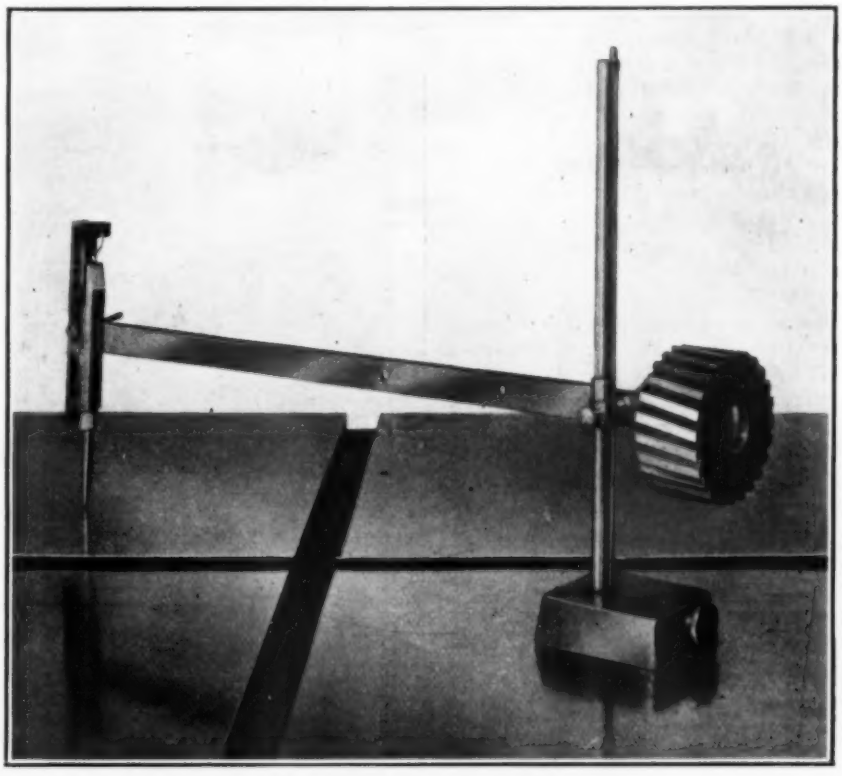


FIG. 2. TESTING A SURFACE PLATE

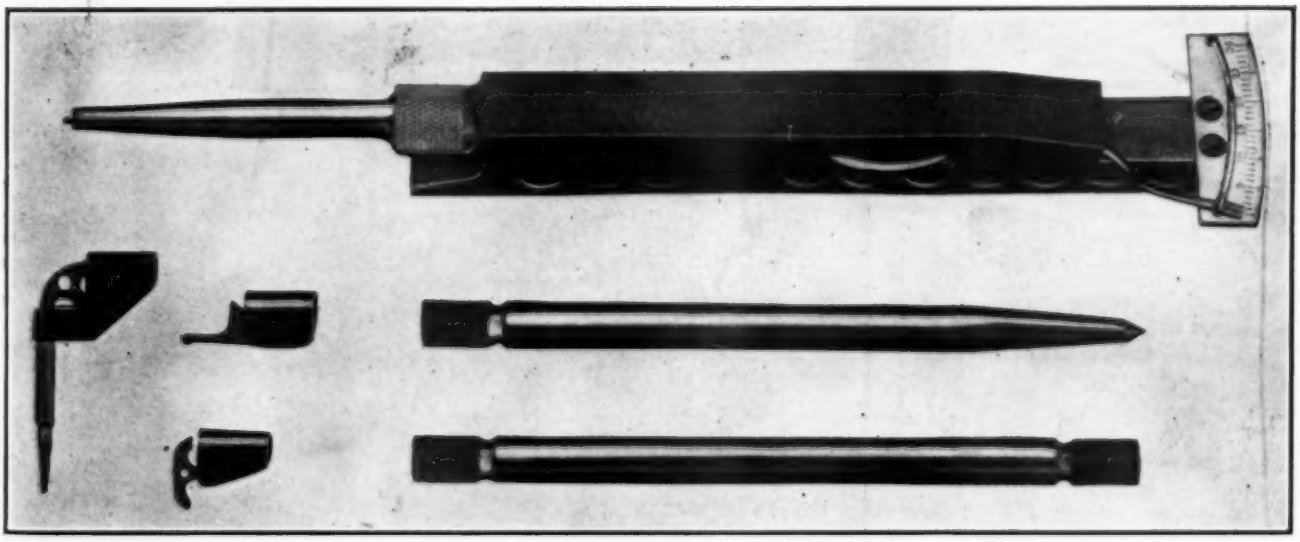


FIG. 1. UNIVERSAL TEST INDICATOR

justable angle plate is used for holding the plate to be tested; the adjustable plate, while preferable, is not, however, indispensable. After testing the angle plate in the position shown and reversing it to bring the face up, the indicator attachment is reversed and the same face tested in that position; if the two tests show the face to be correct, both angle plates are surely correct. On the contrary, if the angle plate being tested shows 0.002 inch high, for example, at the outer edge in the first test, and upon reversing the plate, face up, the same edge is found to be 0.002 inch low, the plate being tested is 0.002 inch out of square and the one used for clamping against is correct.

Assume another test is made as shown in Fig. 3. Suppose the angle plate being inspected is apparently correct at the first test, but when reversed to bring the same face up, the second test shows 0.003 inch out; this will show that each of the angle plates is out of square 0.0015 inch, providing, of course, that they are of the same dimensions. If the adjustable plate, say, is larger than the one being tested, its total error will be proportionately greater.

Take another case which differs from the two above. Say in the first test (as shown in Fig. 3) the angle plate is 0.001 inch high at the outer edge, and when reversed face up for the second test it is found 0.004 inch low, at the same edge; that is, when in the first position, the error of one angle plate is subtracted from the error of the other plate, leaving a difference of 0.001 inch, while upon reversing the angle plate its error is added to the error of the adjustable plate, giving a total error of 0.004. Assuming that the two plates are of the same hight, the adjustable plate

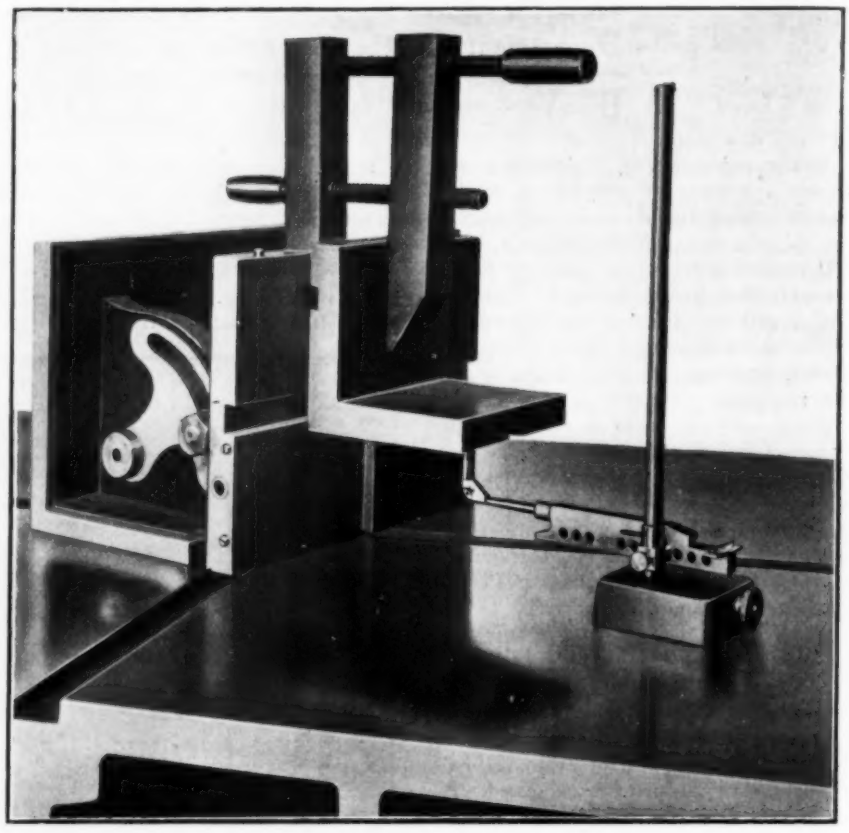


FIG. 3. TESTING AN ANGLE PLATE

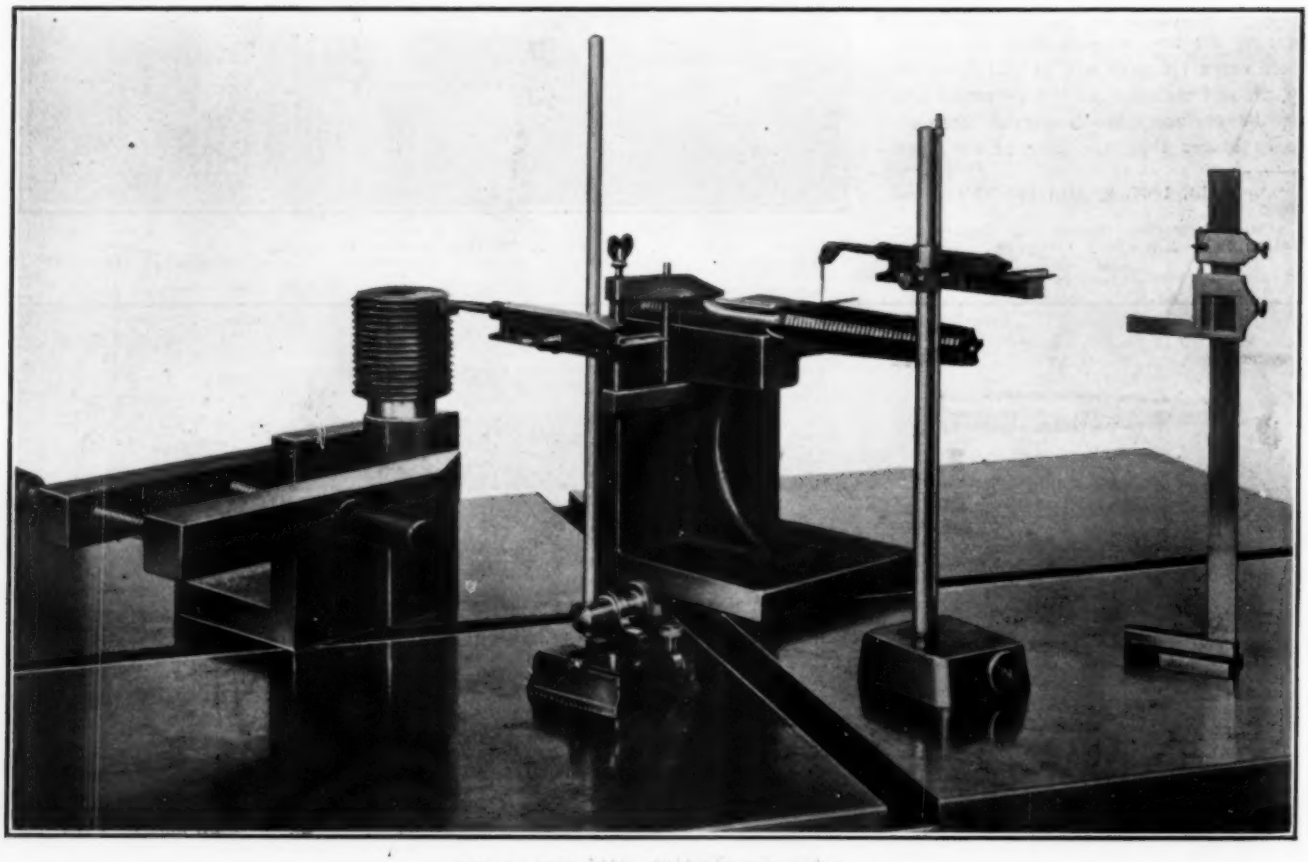


FIG. 4. TWO TESTS ON THREADED WORK

will therefore have an error of 0.0015 and the plate being tested an error of 0.0025, the sum of these two errors being 0.004 and the difference 0.001.

Thread Tests

Fig. 4 shows two different tests. At the left in the photograph is shown a way to test the lead of a threaded plug or tap on a surface plate with the aid of a hight gage and the universal test indicator. When placing the plug in the position shown, it is necessary to draw a center line on the threaded portion; if a tap is held instead, the edge of the flute can be used as a guide line. The test indicator is applied in the thread at one end of the plug or tap, transferring then to the hight gage, taking its reading and repeating the same operation at the other end of the plug or tap. By subtracting the lowest setting of the hight gage from the highest and counting the number of the threads which separate the two tests, the error in the lead, if there be any, will be easily determined.

The other test in Fig. 4 shows how to get the thread-caliper reading on a five-fluted or any other tap, without thread calipers. Place a piece of stubs steel wire in the thread; transfer the total hight as shown by the indicator to the hight gage; then subtract one and one-half times the size of the wire from the total hight found before, which gives the hight of the root of the V-thread. Then find the depth of the thread by dividing 0.866 inch by the number of threads per inch, and add one-half of this result to the hight of the root. Find the hight of the center of the tap by the shank and subtract this distance from the previous result obtained. Multiply the difference by two and the result is the caliper reading. Following is an example further to illustrate this test:

Size of wire = 0.063 inch.

Number of threads per inch = 10.

Hight of top of wire in V = 4.9998 inches.

Hight of center of tap = 4.9053 inches.

Constant for V-thread = 0.866 inch.

0.063 (diameter of wire) × 1½ = 0.0945 inch.

4.9998 — 0.0945 = 4.9053 inches, hight of root of V above surface plate.

0.866 ÷ 10 = 0.0866 inch, depth of thread.

0.0866 inch ÷ 2 = 0.0433 inch.

4.9053 + 0.0433 = 4.9486, hight from surface plate to pitch line.

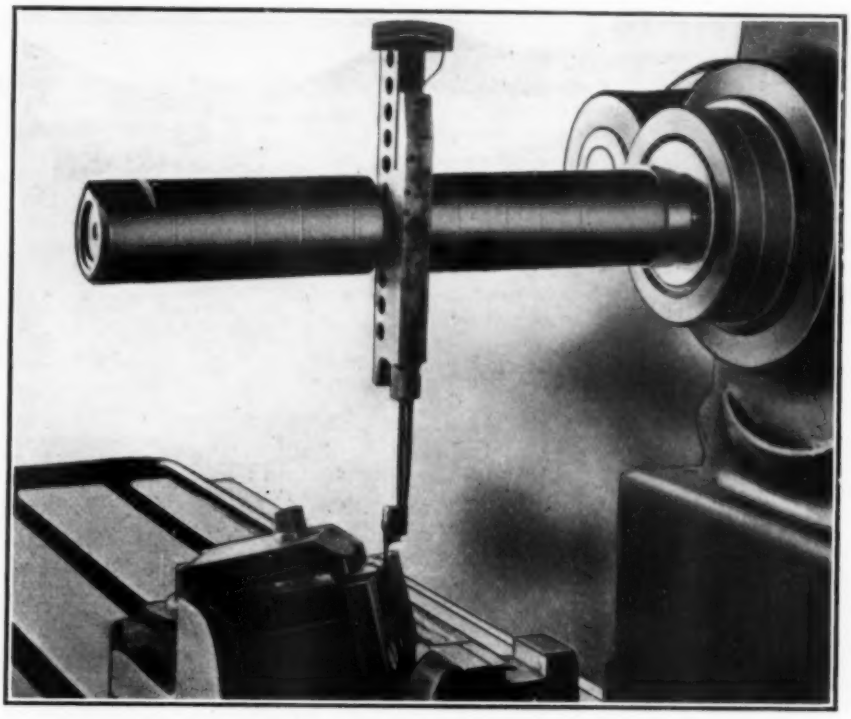


FIG. 6. TESTING A JOB ON THE MILLER

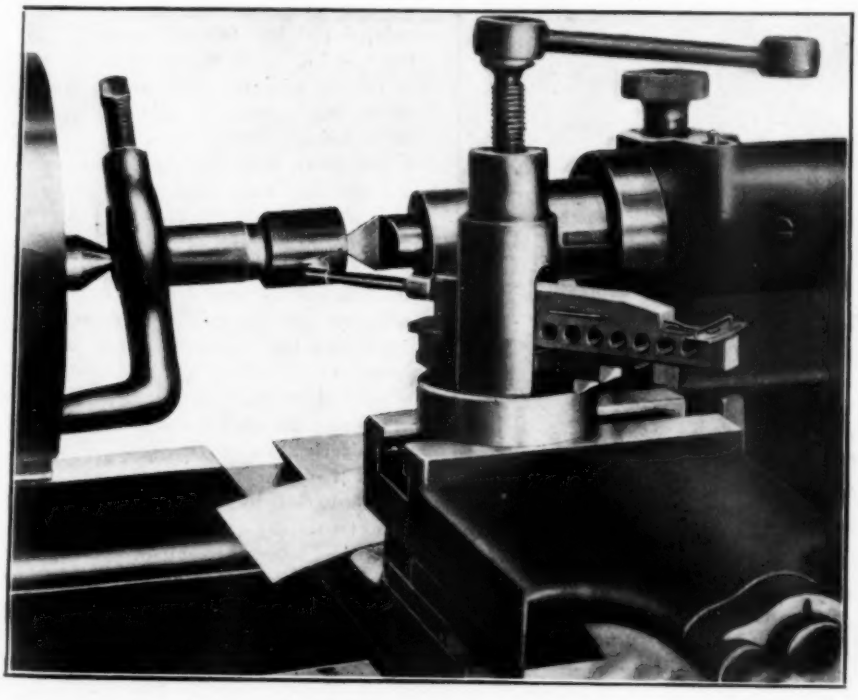


FIG. 5. TESTING A THREADED PLUG IN THE LATHE

4.9486 inches — 4.0494 inches = 0.8992 inch.

0.8992 × 2 = 1.7984 inches, or the proper caliper reading.

1.7984 × 0.0866 inch = 1.885 inches, outside diameter of tap.

In Fig. 5 is shown another way of testing the lead of a thread plug or tap on a lathe by using the same test indicator with one of its regular attachments, which is placed in proper position, giving a direct reading. By engaging the nut of the lead screw to the latter, after placing the instrument as shown in the illustration and revolving the lathe spindle as many times as desired, according to the length of the threads, any error as compared with the lead screw will be plainly shown.

The Indicator in the Milling Machine and Lathe

Fig. 6 shows a method of testing manufactured parts on a fixture in which they have been milled, without the aid of any special gages. Fig. 7 shows how to apply the same instrument for setting a milling-machine vise, or shoe. These two illustrations will suggest the unlimited number of uses to which the instrument can be put, both in the manufacturing and tool-making departments. Fig. 8 shows how to test the truth of the inner face of collars, saws, cutters, etc., that can be reached through the hole or at the outer edge between the jaws of the chuck on the lathe or grinding machine.

Finding the Sizes of Holes in Jigs

In Fig. 9 is shown a method of obtaining the sizes of holes without the aid of plugs while inspecting a jig, the tests being made by reaching at the inside (near the steel seat shown) for the most accurate results. It is very often the case that a jig hole has to be bored to an odd size, and when the toolmaker and inspector run across such a case (before the bushings are to be put in) it is quite common practice to go to the expense of making special plugs. By taking the hight from the inside at the lowest part of the bored hole or lining bushing, as shown, and transferring to the vernier hight gage, then taking the hight at the upper part of the hole by reversing the regular attachment on the indicator, and subtracting one hight from the other, the size of the hole is obtained. Adding one-half of the diameter of the hole to the lower hight already obtained gives the center hight.

Other Uses in Jig Work

The illustration in Fig. 10 shows how to obtain a measurement in a box jig, as in taking the hight of a steel collar or seat around the stud, where the work is to be located. The test indicator is mounted on a surface gage with an extension so as to hold the instrument in an upright position, and the hight when taken is transferred to the hight gage, giving the starting point of all measurements to be taken on the jig.

Fig. 11 shows another way of reaching into a box jig (placed in an upright position) for measurements to be taken and transferred to the hight gage. In testing drill jigs, the most reliable results are obtained by working from the inside of the jig as much as possible. If a hight has to be taken at the outside with a test bar or plug inserted in holes in the jig, great care should be taken to have the bar perfectly parallel with the surface plate, as very often the holes are bored to a slight angle due to springing the jig when clamping it.

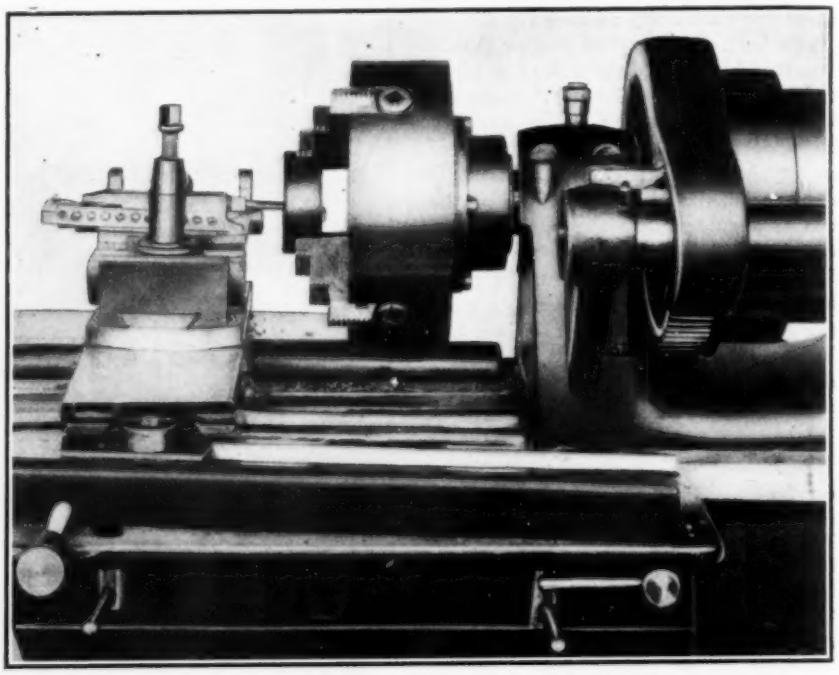


FIG. 8. INDICATING REAR FACE OF A CHUCK JOB

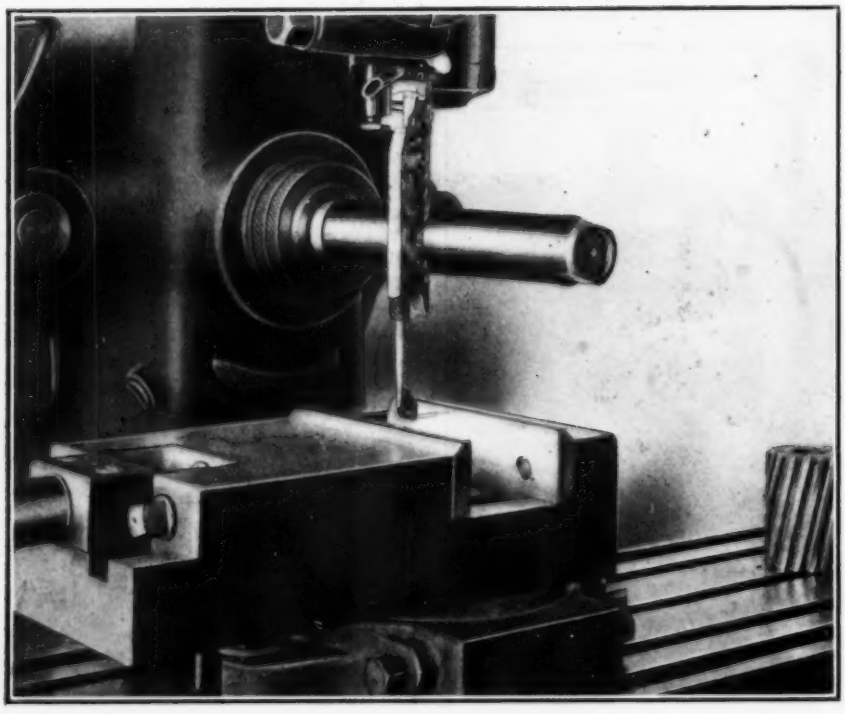


FIG. 7. SETTING A MILLER VISE

Locating a Jig for Boring

In general tool work it is often the case that a drill jig laid out with care is plenty good enough to work to, that is, if the center-punch marks are properly located in the lay-out; the next thing is to follow these center-punch marks. The center marks can be located for setting the work first roughly with the center in the spindle of the machine, then by placing the pointed test bar (shown under the indicator in Fig. 1) in the center-punch mark in the jig with the outer end of the bar on the boring-machine spindle center, the latter being perfectly true. Of course it is necessary to secure close alinement of the test bar both ways. To obtain this alinement, the test indicator may be clamped on the end of the spindle of the machine and brought into contact with the test bar as near to the work as possible, the machine spindle being turned by hand and the readings of the indicator noted at the four quarters; this will plainly show the position of the jig and what adjustments are to be made to locate it properly.

Another way to locate by the center-punch mark is to aline the test bar in position (from the carriage of the machine) with the indicator mounted on the surface gage, using one of the regular attachments to facilitate setting the test bar parallel with the plate. For side alinement an angle plate may be placed on the carriage parallel with the spindle, using the upright surface of the angle plate with the test indicator mounted on the surface gage as before. Thus the test bar is readily set parallel with the surface of the angle plate, giving the proper side location.

The button method of locating jigs is one of the most reliable used. For setting the jig correctly on the machine

carriage the test indicator may be clamped on the end of the spindle, reaching the button by means of one of the indicator attachments; then upon revolving the indicator or testing at the four quarters of the circle, the readings will be alike when the proper location of the jig is obtained.

These methods are applicable to milling-machine as well as boring-mill work; there are many tool departments that do not believe in swinging jigs (whether large or small) on the face plate of a lathe to do the boring.

The Effect of Hardening and Tempering on the Dimensions of Steel

By John Phin

I was very much interested in the correspondence relating to this subject. The question is an old one and in some of its respects quite complicated. One difficulty in determining the question by the ordinary methods of measuring arises from the effect of oxidation. It is almost impossible to harden a piece of steel without oxidizing the surface to some extent, and this, however slight it may be, somewhat affects the measurements made by the usual instruments in the ordinary way of what is known as "end measurements." The only way to avoid this is by "line measurements," which require special apparatus and good microscopes.

In this connection there are two questions to be decided: 1. Is the general bulk enlarged or diminished, and 2, Is this enlargement or diminution in special directions such as length, breadth or thickness?

The second question can be determined only by careful line measurements, but the first question is an exceedingly interesting one since it affects our views in regard to the molecular condition of the steel. If the steel should prove to be en-

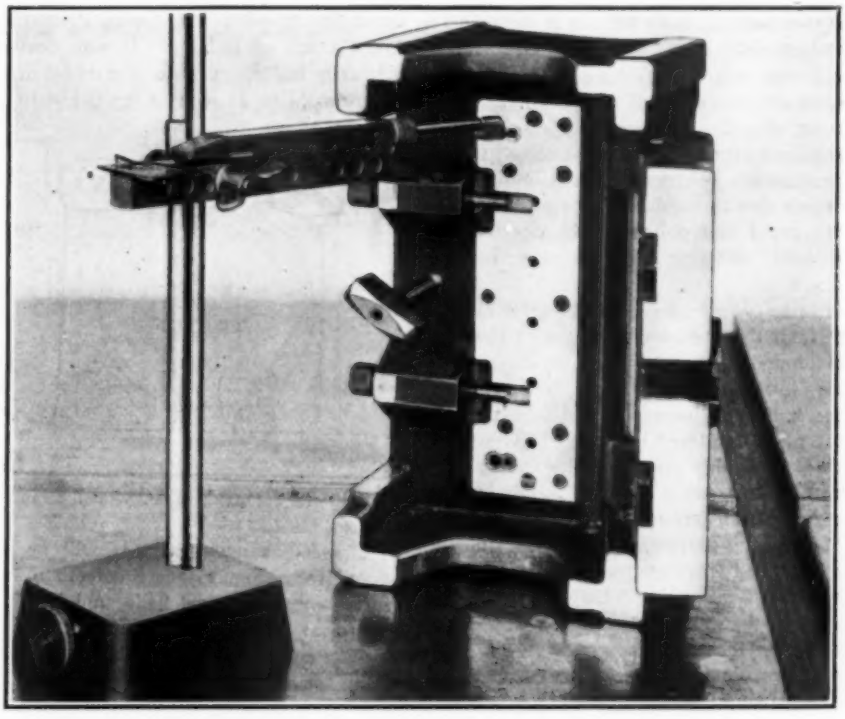


FIG. 9. GETTING SIZE AND CENTER HIGHT OF A HOLE IN A JIG

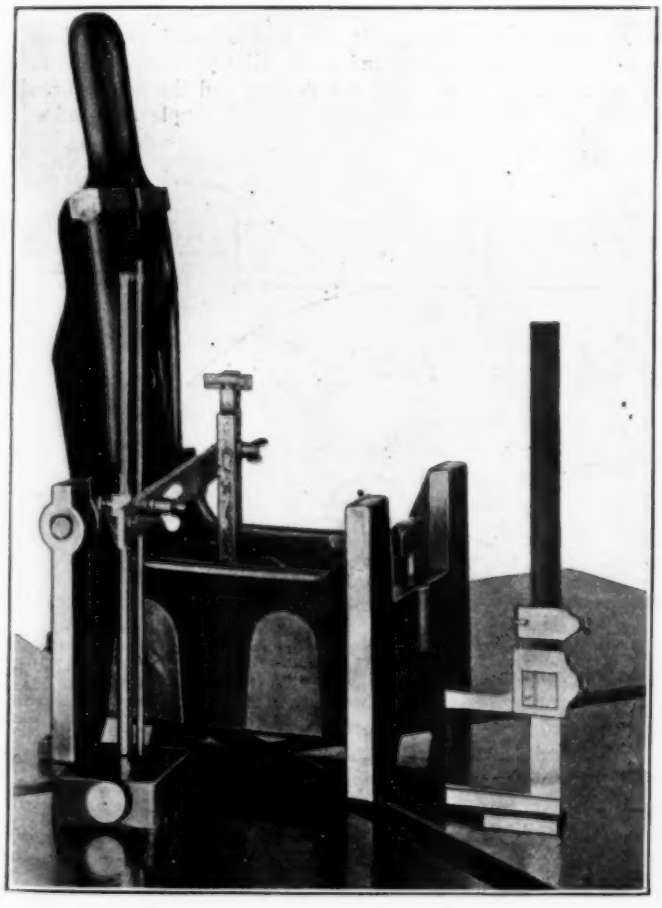


FIG. 10

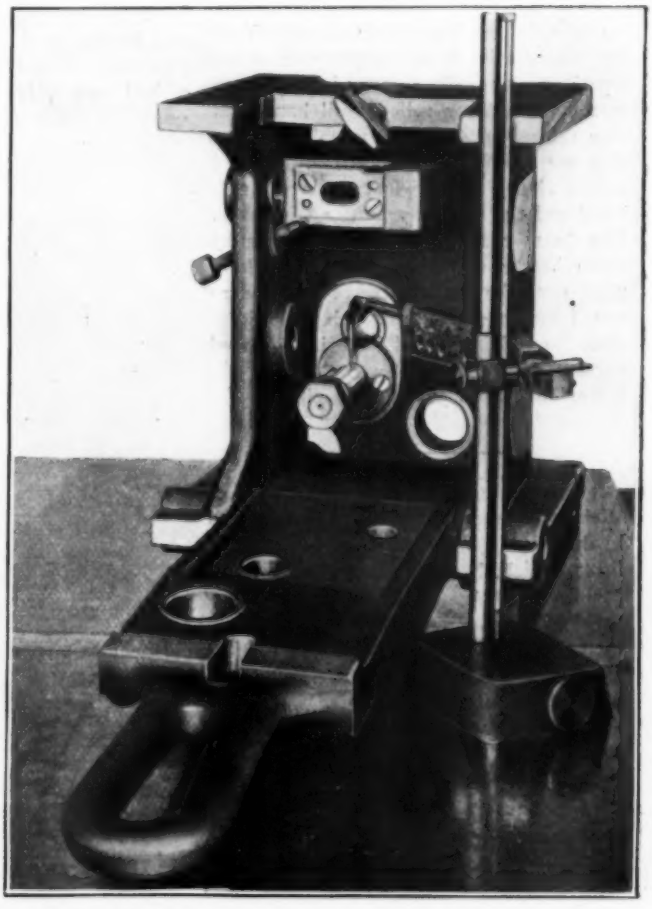


FIG. 11

OTHER APPLICATIONS IN CONNECTION WITH JIG WORK

larged in bulk by hardening, then we have the curious condition that the steel becomes harder by being less condensed. This, as we all know, is the reverse of what occurs with most other metals—copper, silver, brass, etc. A piece of brass when hammered or rolled becomes denser, harder and more springy; is it the reverse with steel?

Fortunately we have a simple and very accurate method of determining this point, that is, by comparing the specific gravity of the same piece of steel in both conditions. We can then eliminate all errors due to oxidation, etc., because we can grind and polish the hardened piece without affecting the accuracy of the result.

Some years ago I made very careful tests of this, and found that with the old-fashioned tool steel the specific gravity was lowered by hardening, that is to say, the bulk was increased and consequently the metal rendered less dense. The work was done with great care by means of a very fine Oertling balance, and it is well known to all physicists that the operation of weighing gives results which cannot be approached for accuracy by any other system of measuring. So delicate is this method that it was by a slight difference between the specific gravities of pure nitrogen obtained by chemical means and that procured from air that argon was discovered and identified.

The same tests applied to brass showed directly the reverse—the soft brass was the least dense. To get rid of any errors that might arise from the presence of internal vacuities, the pieces of brass were first hammered or rolled until hard, and then the specific gravity was taken. Then they were softened by heating, weighed to see if any change had occurred, polished and the specific gravity again taken. The brass was always the most bulky when in the soft condition. In making these tests the same pieces of metal were tested and compared in both conditions, since no reliance could have been placed upon results obtained by comparing different conditions of different pieces.

It is stated by the consulate at Swansea, Wales, that there was recently introduced to the tinning industry a patent riser and lister, which, however, is still in the experimental stage. It is an ingenious invention and can be applied or connected to the tinning pot in such a way that by means of rollers and conveyers the tinplate sheet after being coated is quickly transferred from the grease pot to the bran tub without the use or mark of tongs. The services of the extra rollers tend to minimize the "list," thus saving metal and producing a splendid surface, while the conveyers do the work of the risers, the latter being a saving of 2 cents per box.

Collier's Ball Worm Gear

By W. H. Booth

The accompanying sketches show a curious form of worm gear recently patented in America and Great Britain by Mr. Collier, of London. It was devised primarily for the purpose of a direct drive in automobiles, as well as for the purpose

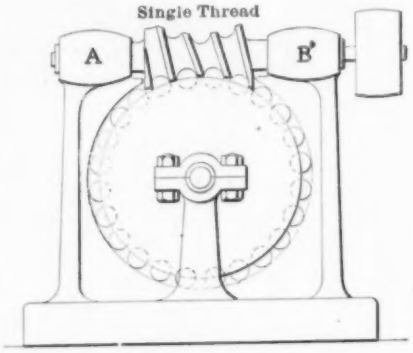


FIG. 1. COLLIER'S BALL WORM GEAR

of a speed-change gear. It will be observed from Fig. 1 that the teeth of the worm wheel are steel balls sunk to their equatorial line in cups bored in the body of the wheel. The wheel runs in a guard, which prevents the balls from leaving their sockets, and in practical work an oil-bath container is used. The worm which gears with this ball wheel may have any number of threads. Usually it will be single, double or triple threaded. Obviously the contact of the worm and of a ball can only be, at most, along a quadrant of a circle on the diametral plane taken parallel with the face of the worm wheel; that is to say, on the longitudinal center line of the worm.

If the pitch from center to center of adjacent threads is always made equal to the distance apart of the balls which form the teeth, then any worm, no matter what its type, single, double or multiple threaded, will gear properly with the ball-tooth gear wheel. Thus, while forming a direct drive upon the axle, this gear admits of as many changes of speed as there are worms upon the worm shaft.

The worms are made, as shown in Fig. 1, to fit round the curvature of the wheel rim. Thus a worm may be quite loose on a feather key, yet it will not screw itself out of gear as would a plain parallel worm. Thus no particular device is needed to counteract this tendency, though such a one may be mechanically desirable.

In adapting this gear, which is here shown in the crude form of the patent drawings, the bearings *A* and *B* would be put a considerable distance apart and there would be a universal joint in the worm shaft between the worm and the bearing *A*. The bearing *B* would be movable on a slide or on a bar, and so arranged that by the movement of a lever the worm shaft would be moved away from the worm wheel to such an angle as to disengage the worm. There would be three worms, as in Fig. 2, and a second movement of the lever would slide the combined three worms along the shaft; a third movement of possibly the same lever would bring the shaft back to its working position.

Thus let us assume a 30-inch wheel at a speed of 600 revolutions per minute, or say approximately 54 miles per hour. The worm, if triple threaded, would run at 1800 revolutions per minute, with the 24 balls of the illustration, or at 900 revolutions per minute if a wheel of 12 balls was employed. With the same engine speeds the vehicle speed would drop to 27 and to 18 miles per hour, respectively, with the double- and the single-threaded worms in use. A simple spur-reduction gear may be interposed between the engine and the worm shaft, if desired; but in no case need there be any rattling change of toothed gearing. The three worms and the engine itself afford all the range of speed that can be desired.

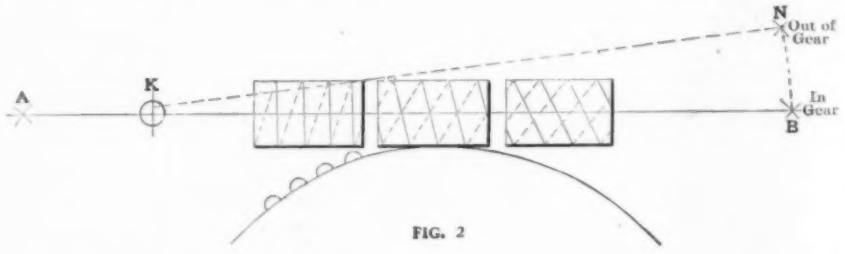


FIG. 2

FIG. 3
ARRANGEMENT OF WORMS AND BALL-HOLDING DEVICE

In Fig. 2 *A* represents the bearing shown at *A* in Fig. 1; *K* is the universal joint of the worm shaft and *B* is the other bearing. This is movable to allow the worm shaft to move to the angle *K N*, or

sufficient to disengage the worm so that it may be slid along the spindle to the next speed. Such a combination movement might well be arranged with a pull-up handle, which would then be pushed over a locking quadrant. This push would serve to move the worms along their shaft. Then when either of the extreme worms was in place the lever would have reached a drop-down slot in the quadrant and the worm would be dropped into gear again. Every designer would have his own method of effecting the two operations with practically a single movement. A safe interlocking device, such as the idea just outlined, could be easily made. It might be thought that the balls, which are not guarded by the circular guard, would drop out of their pockets when the worms were put out of gear, but this is guarded against, as shown in Fig. 3, by the addition of little lateral extensions of the wheel rim at each ball socket. These little extensions stand above the centers of the balls so that they can be closed in upon them and prevent their escape. In changing speed there is then no danger of the balls jumping out of their sockets. The small extension pieces can also be closed in as wear takes place. The annular guard is not really necessary when these extension pieces are fitted.

In manufacture the threads of the worms are cut by a tool or tools fixed on a frame capable of turning about an axis, which is located at the same distance from the axis of the worm shaft as that of the wheel with which it is to be used. The worm and tool carrier are suitably rotated and a feed given to the tool. The worm is very easily cut either by a single tool or by a series of tools.

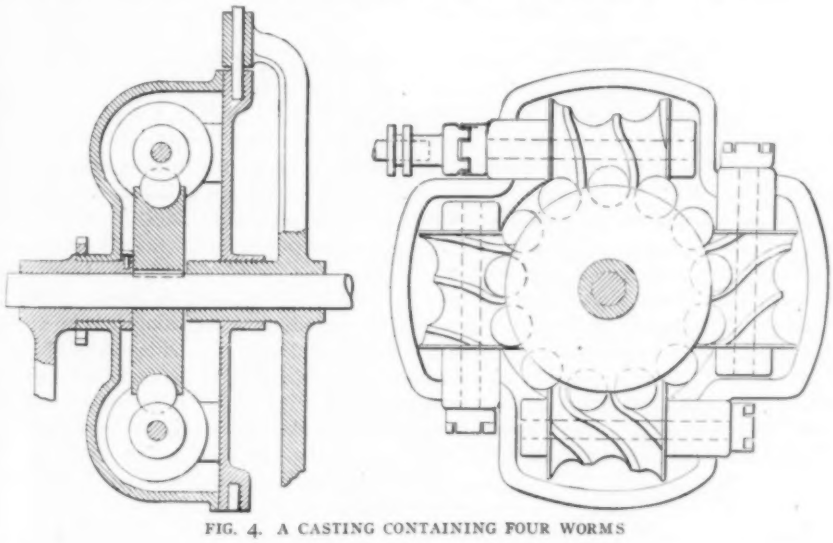


FIG. 4. A CASTING CONTAINING FOUR WORMS

But in connection with the automobile, for which this ball worm gear is more particularly designed, the problem of changing the gear has been very much simplified by the inventor. In this design he gets rid of the three or four worms on one shaft, which require so much longitudinal shifting and involve the removal of the worms from out of gear when changing speed, and substitutes, for this somewhat cumbersome arrangement, a casing which surrounds the worm wheel and carries, as shown in Fig. 4, four worm spindles, each holding a worm and projecting through the casing. Each terminates in a clutch end. The casing is made to rotate about the center of the axle with which it is concentric. It is rotated by means of a lever and gearing connection 90 or 180 degrees, in the case of four speeds, for any change of speed desired. There are as many locking notches on the rim of the casing as there are worms in the case. Thus the case is locked firmly at any worm position.

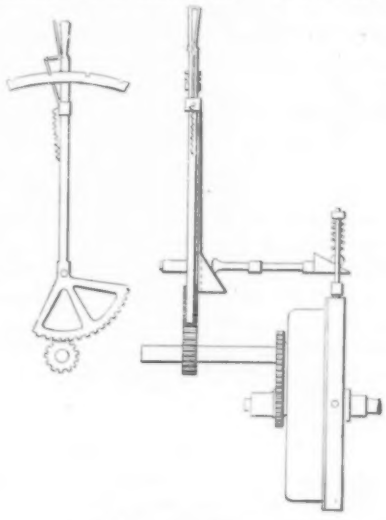


FIG. 5. A REVERSING GEAR

One peculiarity of the ball worm gear is that the wheel gears equally well with right- or left-handed worms. In Fig. 4 there are single-, double- and triple-threaded right-handed worms for forward running, and there is a single-thread left-handed worm for slow backward running. Thus in one casing there are three running and one reverse speeds in this particular example. There is, however, no objection to the use of a different number of worms, save that four appear to be sufficient.

The clutch on the clutch shaft must be slid out of gear before the casing can be rotated. The movement of the clutch is short. This done, the casing is rotated to the desired speed position, locked and the clutch slipped back into engagement.

The arrangement of levers for rotating and locking the casing, together with the gears and the locking-gear actuating wedges, are shown clearly in Fig. 5. The whole combination in its most compact form is employed for the reversing and speed-changing direct drive for automobiles of all descriptions.

Hardening and Tempering High-speed Steel

By James Steele

I have taken great interest in what has been said through your columns in reference to the hardening of high-speed steel, and I have often thought that the majority of the troubles in using high-speed steel have been because it was not hardened properly. High-speed steel will begin to harden at 850 degrees Centigrade and continue to get better as the heat is raised.

When a tool is heated to 850 to 950 degrees Centigrade and cooled, this tool will not give satisfaction. The temper can be drawn by the grinding, or when in use it will not stand the speed that is expected of this class of steel. A great deal of this kind of hardening comes from the use of improper methods or appliances in the heating. As it is immaterial how the steel is cooled after it is brought to the proper heat, it will be hard even if it is put in lime.

In my experience I find that fish oil is to be preferred for all tools, including lathe tools. I have seen some tool dressers cool their lathe tools in water; but this will only injure the steel, providing it has had the proper heat, and the grain of the tool will have the appearance of a piece of galvanized work.

Heating in a Forge

The forge fire as is commonly used can be one of the poorest possible places in which to heat high-speed steel; it is possible to prepare the forge so that the high-speed steel can be brought to 1400 degrees Centigrade with some degree of satisfaction, but not on tools such as milling cutters or reamers. They can be hardened in the forge, but cannot be brought to 1400 degrees Centigrade with safety. The forge should be prepared for heating high-speed steel, care being taken that the tool does not come within 7 inches of the tuyere iron or the hole in the blast pipe. Coke should be used to raise the fire to this hight from the tuyere iron. After having

put in sufficient coke, the two sides should be raised with green smithing coal to a point about 4 inches above the coke. Then place two fire bricks over the top, thus forming a chamber 4 inches high and wide enough to permit the safe turning of the tool. Fill this chamber with coke, turn on the blast and let the fire come up slowly, thus being sure that the sulphur is all burned out before the tool is put in place to heat. After putting in the tool, let the heat come up slowly until it reaches a cherry red; then give the fire more blast and continue to force the heat until it reaches a bright orange color. Shut off a part of the blast and let it continue to heat until it reaches a brilliant white, or until it gets as hot as is possible without blistering; then immerse in fish oil to cool.

Can't Get Too Hot in a Forge Fire

There is not any danger of getting high-speed steel too hot in a forge fire, but there is grave danger of blistering it so the tool cannot be used. The blistering is not caused by the heat, but by the blast; as in a properly constructed furnace where the blast can be kept from the work while heating, the steel can be heated to a dazzling white without blistering. The heat should be watched very carefully, and when the piece has reached the high heat the tool should be taken from the fire *at once*. If allowed to continue at the high heat, the steel or tool will be coarse grained, break easily and not give the satisfaction of a tool with the extremely fine grain.

There are several rules that should be observed when examining to see if the proper heat has been obtained in the hardening. The grain wants to be very fine, in fact, we would say as fine as silk. After hardening a test piece (being sure the piece has not been hardened before), break it to see the grain; then draw to a pigeon blue and let cool in the open air. If the piece is as hard as it was before drawing, it has had the proper heat providing the grain is fine. On the other hand, if it is found to be soft after this treatment, it has not had a sufficient heat to stand a very high speed. This test applies only to steel that has been hardened but once, as the second hardening will produce different results.

Don't Temper High-speed Steel

As to the tempering of high-speed steel, I do not consider that it can be tempered if it is heated to 1400 degrees Centigrade (or more) when hardening, it being impossible, except by annealing, to change the hardness of a tool brought to that heat. But high-speed steel hardened at 950 degrees Centigrade can be tempered. The value of a high-speed tool hardened at this heat will not equal carbon steel, and yet it has the appearance of being harder when tested with a file. Not until it is placed in use and the tool is heated from the high speed of the work, will the trouble begin. In my opinion this is why we hear of so many complaints in the use of high-speed steel, whereas if the steel was heated to 1400 degrees Centigrade it cannot be drawn.

This may sound strange to some, but I do not know of any way of drawing the temper in high-speed steel after it is heated as stated. The proper way of testing for the temper would be to work the tools, before tempering and then again after tempering, at what they are intended for. In tests of this kind I much prefer that the man using the tool be entirely ignorant as to which tool is tempered, as it seems that the tempering of any kind of steel is a hard thing for some to give up. When the tool is drawn, the operator feels that all is done that is possible to do; hence he gets along better from the fact that he knows of nothing more to do, and he is careful not to go beyond a certain point with his feed, etc.

Dangers of Drawing Temper

I have taken high-speed steel and drawn it at all heats commonly given carbon steel, then heated it to 400 degrees Centigrade (not on the same piece), and I have not even injured its cutting qualities; but in a great many cases the tool has been found checked, caused by the tempering. Therefore, I advise carbon steel, where a tool must be soft after it is tempered.

I have seen high-speed tools working side by side, one being drawn to 425 degrees Centigrade and the other not drawn at all; invariably the tool that was not drawn did better work than the one tempered at any heat. Where our loss from breaking in use is 7 per cent. in tempered tools, the loss in tools not tempered is one-fifth of 1 per cent. So it is again a point in favor of not drawing the temper. While there seems but little hope of convincing the average mechanic that to temper high-speed steel injures it, I will ask that such take a piece of annealed stock, cut two pieces from the center of the bar, harden each piece, heating to 1400 degrees Centigrade or more, then draw one piece to any heat that seems to suit. Mark with a private mark and send them out to be used. Note results, then quit the tempering of high-speed steel.

Re-hardening Steel

There is one point I wish the reader to understand thoroughly: that is, that a tool such as a lathe tool that has had more than one heat cannot be considered, as it requires different treatment. I also wish to state here that in hardening high-speed steel the proper heat should be determined upon by experimenting; then heat to this point at all times. Re-hardened high-speed steel may do for some classes of work as well as steel of the first hardening, but it cannot equal the tool hardened but once, at the proper heat. Even when the tool is annealed properly and then re-hardened, it cannot be expected to stand on all classes of work with the tool hardened but once, at the proper heat.

Some Small-tool Troubles and Their Remedies

By Ethan Viall

In every shop there is more or less trouble with small tools, arising from a variety of causes. Some of these are easily overcome, while others are more difficult to remedy. It is possible that a few of our treatments of such cases may be helpful to others.

Thread Chasers

In our shop we use a large amount of brass in the manufacture of faucets, valves, and similar goods. As a great deal of scrap brass from various sources is used in the foundry, it is impossible to obtain a uniform grade of castings.

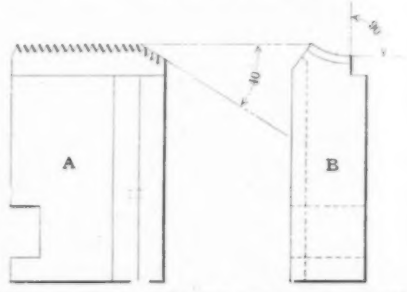


FIG. 1. THREAD CHASERS FOR SELF-OPENING CHUCKS

Thus the machining of the product is sometimes a serious problem, the cutting of satisfactory threads being one of the worst. We have found that for thread chasers used in the self-opening chucks, the proper angle for grinding the chamfer is 40 degrees, this angle working best where our brass varies from hard to soft. The cut *A* of Fig. 1 shows the manner in which we measure the angle.

In grinding the cutting edges of the teeth we do not use either a hook or a rake, but grind them 90 degrees, as shown at *b* of Fig. 1. The holder used while grinding the chasers is so arranged that it may be tilted in order to keep this angle constant as the chaser gradually wears away.

The one exception to this rule is in the grinding of chasers for brass tubing. These are given a hook just the same as if they were being ground for iron. The tubing we use is very hard.

For some time we had considerable trouble from the bur left between the chaser teeth by grinding. We removed these burs at first by lapping on a lap of the same pitch and size as the chaser was made to cut; but this was too much bother; after some experimenting we adopted an ordinary scratch brush for the

purpose. With a little practice one can remove the burs from a chaser or tap almost instantly without the slightest injury to the thread.

The scratch brush we use is 6 inches in diameter, 1½ inches thick, has wire 0.005 inch in diameter—35 Birmingham gage—and runs at a speed of 3400 revolutions per minute. The chaser is held in the fingers with the cutting edges down and with the wheel revolving toward the operator. It is quickly pressed straight into the brush, and instantly withdrawn. I think that the correspondent who asked some time ago for a method of removing burs from the threads of screws slotted on a milling machine may see a solution of his trouble in this process.

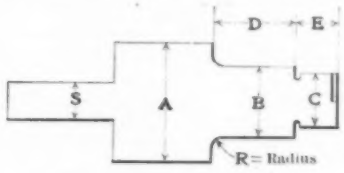
Drills for a Nut Machine

Our automatic nut machines use very soft cold-rolled hexagon steel, and at one time the breakage of drills on the machines using sizes from 3/16 inch up to ⅜ inch was something frightful. Now, when a new drill is put in, it is broken off for half the length of the flutes. This makes a stiffer drill and the cutting lips are ground as if for brass, that is, straight like a flat drill. Since following this practice our expense for drills is not 10 per cent. of what it was before.

The inexperienced hand on an automatic nut machine almost invariably sets his drill out too far, and as a consequence when the nut is cut off and the stock feeds up again, there is a hole partly drilled in the end of the bar. If for any cause it is not central, the drill has no chance to straighten it. The drill should be so set that after the nut is cut off there is left a depression in the end of the bar no deeper than the cutting lips of the drill; then if this depression is not central when the stock feeds up and the chuck closes, the drill has a chance to center itself.

A Self-cleaning Chuck

Several old hand screw machines were converted into automatics by the addition of a cam system, and one of our troubles was the frequent clogging of the spring chuck collets with dirt. This was remedied by drilling four ¼-inch holes through the chuck cap and letting the soap water wash out the dirt, as well as keep the tools cool. A sheet-metal cap projecting over the chuck is used to prevent the throwing of the soap water over the floor. This was thoroughly effective and no further trouble was experienced from accumulating dirt and grease.



Bin	A	B	C	D	E	R	S
601	2″	1¼″	½″	1″	⅛″	1/16″	¾″
602	2″	1⅜″	⅛″	1 1/16″	3/16″	5/32″	¾″
603	1¼″	1″	¾″	2″	9/32″	1/16″	¾″
604	1¾″	¾″	0.409″	21/64″	1/16″	¼″	¾″
605	1½″	¾″	0.527″	19/32″	11/32″	1/16″	¾″

FIG. 3. A DRILL GRINDING CHART

Grinding Cold Chisels

In grinding the cold chisels used in chipping castings in the foundry, we have less trouble when the chisels are ground with rounded corners at the cutting edge. This is an old method, but I have found lots of good mechanics who never heard or thought of it.

A "Novo" Screwdriver

In one of our assembling jobs an unusually strong screwdriver is needed. Owing to its peculiar shape we had great difficulty in getting anything that would last. The slot in the head of the screw is 3/16 inch wide and 5/8 inch long, and is at the bottom of a hole 3 inches deep. A slide in this hole prevents the insertion of a screwdriver blade thicker than 3/32 inch. The blade must therefore be 3/32 inch thick, 5/8 inch wide and kept to this size for at least 3 inches of its length.

After trying various steels we got some unhardened "Novo" of the proper size, and have stopped the "holler" in that quarter. For though the screwdriver is invariably twisted at the final turn with a wrench, it holds like a charm.

WORKMANS TOOL RECORD

Tools for executing *1 1/4" Ex-Oval way female union meter gas cock body Iron Pipe end*

Box Tool	No.	
Drill	No.	*33*
Tap	No.	*19*
Die Head	No.	
Chasers	No.	
Chuck Jaws	No.	*120*
Undercut Blade	No.	
Templet	No.	*294*
Tool Holder	No.	
Reamer	No.	
Tap Holder	No.	*18*
Pilot	No.	
Jig	No.	
Mandrel	No.	

FIG. 2. WORKMAN'S TOOL RECORD FORM

Tools Needed for a Job

A good many shops leave the selection of tools for a job to the workman, thereby losing valuable time. The way we do is to keep cards for each job—similar to the one shown by Fig. 2—in a case near the foreman's desk. When he gives a workman a job he hands him one of these cards, and the workman goes to the tool room and checks out the tools indicated, together with a blue print. The numbers on the card indicate the bin numbers in the tool room. When the job is finished, this card is returned to the foreman, together with a record of the number of pieces and the time.

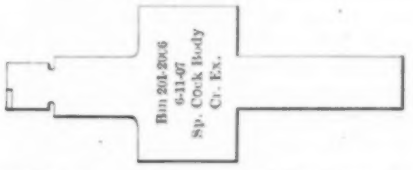


FIG. 4. A FLAT DRILL AND MARKINGS

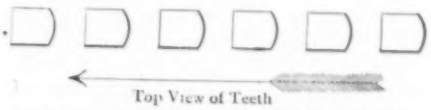


FIG. 5. TEETH OF A TAP WHICH CAUSED TROUBLE

These cards are made up in the drafting room when the blue prints are made for the job, and copies are made by a boy as needed; but several of each are always kept ready for use.

Grinding Sizes for Drills

As we have over eight hundred kinds of special flat drills, and from six to thirty-six of each kind, their accurate grinding was something of a problem. In order to save constant reference to blue prints, a chart was made, as shown in part by Fig. 3.

As the bin number is stamped on all our tools of every description, this was an easy means of identification.

It is obvious that in regrinding the dimensions *d*, *e* and *R* are the only ones commonly used, though the others are used in the first grinding and for reference.

In addition to the bin number all our tools are stamped with a special tool number—the same as that on the original drawing—the date made, the steel used, and for what job the tool is used. For instance, if it is a flat drill for use in drilling a special cock body, it would be marked similar to Fig. 4. The number 2006 is the special tool number. Cr. Ex. means that crescent extra steel was used. This latter and the date not only show

how a certain steel stands the wear, but are also useful in case the tool needs re-hardening.

A Tap Puzzle

Several weeks ago a 1-inch square-thread, eight-pitch, machine-relieved tap which was cut on a Hendy lathe after fluting, using their relieving attachment, was put into a turret machine. Instead of cutting a thread it simply tore into the hole, taking out the metal and leaving a 1-inch hole. The tap was taken out and carefully reground. On being replaced it did exactly the same thing. As out of hundreds of taps made this was the first to act in this manner, we were "up a stump" for a while. Careful examination, however, revealed the cause but not the origin of the trouble. The teeth of the tap are shown by Fig. 5.

The front of the teeth were flat, without the slightest hollow, while the back of the teeth were convexed the long way of the tooth. This caused the tap to feed in rapidly and at the same time shear out the metal. Now how any lost motion in the relieving attachment or inaccurate setting of the tool could generate a tooth flat on one side and curved on the other, as shown, is more than we can figure. If the tooth had been concave on one side and convex on the other, the explanation would have been simple. As this is the only case in our experience, we should like to hear of any similar one. Of course, the sketch is exaggerated, but the curve could easily be seen, while the most careful use of a scale and miscroscope failed to reveal any hollow in the front side of the tooth.

The direct application of jets of dry steam to a gravel bank, through the agency of driven pipes, has been found to be an efficient method for thawing frozen gravel.

Design of a Four-stage Turbine Pump

By C. W. Clifford

The condition which the designer had to meet after he had made a preliminary survey, was the draining of a mine, in the Lake Superior region, of 1,656,000 gallons of water daily (24 hours). But it was necessary to pump this quantity in 12 hours. The head against which this water had to be pumped was 1000 feet.

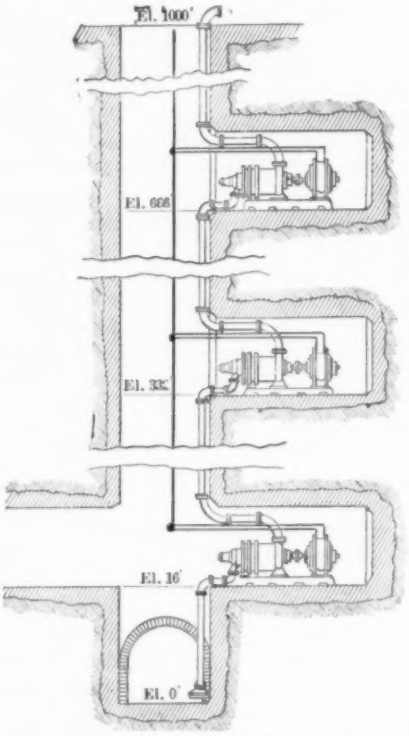


FIG. 1. ARRANGEMENT OF THE FOUR-STAGE CENTRIFUGAL PUMPS

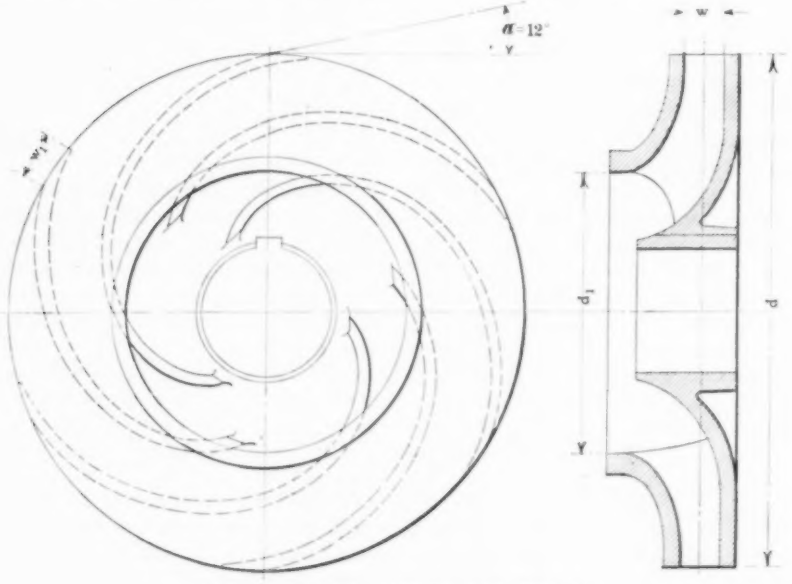


FIG. 2. THE IMPELLER OF THE PUMPS

It was decided to use three sets of four-stage centrifugal pumps arranged at elevations 16, 332 and 666 feet, as shown in Fig. 1, the discharge of the first being the suction of the second, and so on.

It was further decided to use the turbine type of pump which involves the use of the diffusion vanes; as the capacity was to be 2300 gallons per minute, a 10-inch pump discharge was used. The velocity of the discharge was 9.37 feet per second.

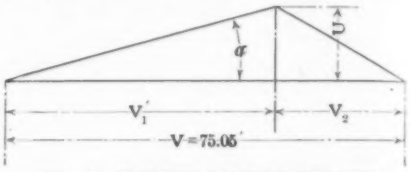


FIG. 3. VELOCITY DIAGRAM FOR THE IMPELLERS

FIG. 4. THE DIFFUSION VANES

The Impeller

The impeller, Fig. 2, was designed more from theory than actual tests. The peripheral speed was found from calculation to be $1.015\sqrt{2gh}$, or 75.05 feet per second; h was 85 feet for each impeller, g was the acceleration due to gravity, and the factor 1.015 a constant which was more of an assumption than calculation. The diameter d of the impeller was equal to $\frac{12 \times 60 \times 75.05}{850 \times \pi} = 20.24$ inches. The speed was 850 revolutions per minute. A diagram of velocities was then laid out in which the peripheral velocity $V = 75.05$ feet per second, see Fig. 3. The other velocities V_1 and V_2 were obtained from the equation $2gh = 2VV_2$, from which $V_2 = 36.4$ feet per second, which makes $V_1 = 75.05 - 36.4 = 38.65$ feet per second. As the radial velocity V was to be about eight feet per second, we took as a trial the tangent of the angle $\alpha = \frac{8}{38.65}$, which equals 11 degrees, 42 minutes; so we call the angle $\alpha = 12$ degrees for convenience, making the radial velocity equal to the tangent of 12 degrees multiplied by 38.65, or 8.215 feet per second.

The outflow area that was necessary in our impeller was then found to be

$$area = \frac{2300 \times 144}{7.48 \times 60 \times 8.215 \times 0.85} = 105 \text{ square inches.}$$

The 85 per cent. in the equation allows for a contraction of area in the impeller; the other quantities are readily understood. In Fig. 2 W_1 was approximately 1¾ inches; there being six vanes, this area taken into account gives us W, or the width of the impeller, to be 1.875 inches. The vanes were then plotted as shown in Fig. 2, keeping the distance between them nearly constant and of uniform section. Care was exercised to increase the velocity as gradually as possible, keeping the velocity line of the diagram nearly a straight line.

The suction of the pump was 10 inches in diameter. The suction velocity was 9.37 feet per second. Increasing the velocity from the suction mouth gave a velocity of 11 feet per second at the opening of the impeller, from which, after taking the diameter of the shaft into consideration, we obtained d^1. It was also thought that to make three long and three short vanes in the impeller would tend to reduce the amount of shock.

The Diffusion Vanes

Next in design were the diffusion vanes, Fig. 4. It was the designer's object to have them receive the water at its high tangential velocity, to reduce this gradually, at the same time to change its direction to nearly a directly radial one and finally to discharge through the ports shown in Fig. 4, at two feet per second.

The long passages of the diffusion vanes will be noticed, and their arrangement, so that the water passes alternately through the ports.

Fig. 5 shows a longitudinal section in which the passages from one stage to another are shown as exceedingly large. Bearings of ordinary design were used and a small bearing took care of what little end thrust there was. Particular care was taken to have all of the passages through the pump as smooth as possible, to eliminate all unnecessary eddies. These pumps were to be motor driven, and both motor and pump were to have a common bed plate.

The pumps were thoroughly tested, and the curve, Fig. 6, shows a mean of the several curves originally plotted from the test.

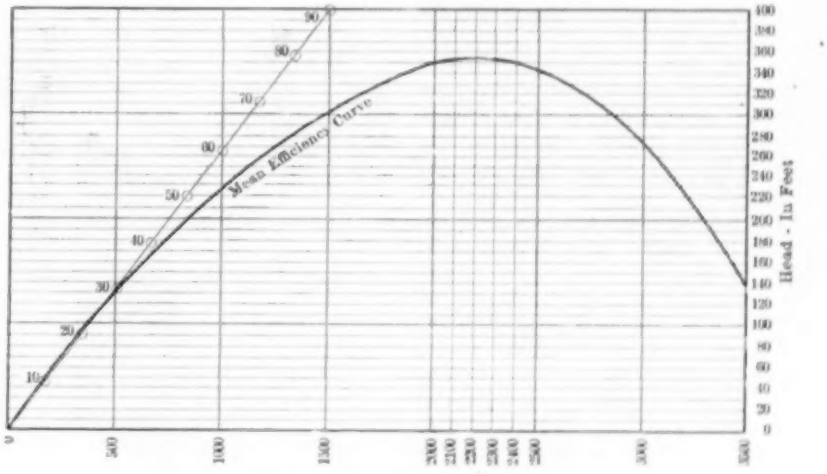


FIG. 6. EFFICIENCY CURVE OF THE FOUR-STAGE PUMP

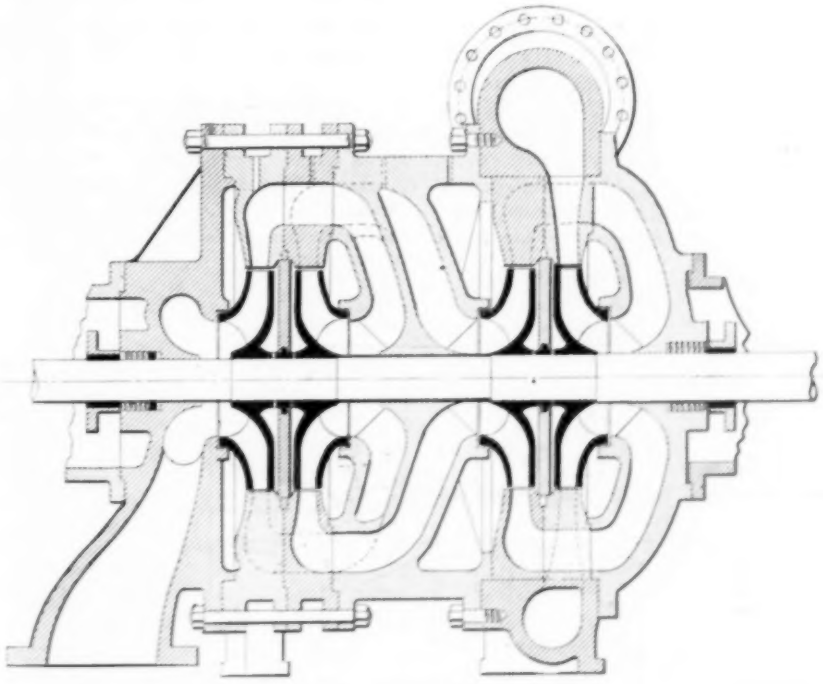


FIG. 5. CROSS-SECTION OF THE PUMPS

A 28-chime Gabriel horn, with a keyboard enabling all sorts of tunes to be played, is the latest. The chauffer will now have to add music to the list of subjects to be studied to make him competent to take charge of an automobile.

Odd Cause of Blow-holes

By E. A. Dixie

At the Straight Line Engine Works in Syracuse they have a foundry where some pretty large castings are made. They have recently made a number of large pans off the same pattern for the Solvay Process Company. Out of the lot of nearly one hundred pieces there have been only two wasters, and these were due to a cause which I have never seen advanced before. The molds in these two instances were finished on Friday, and owing to no heat being run on Saturday the molds were allowed to stand till Monday. When the castings were knocked out of the sand, it was found that they were both wasters. Subsequently it was found that some seeds were in the sand from which the molds were made, and the long time from Friday till Monday gave these seeds time to germinate. When the hot iron was poured on the sprouting seeds, blow-holes developed and the castings were spoiled.

Surface cars on the "Pay-as-you-enter" plan, devised by W. G. Ross and D. MacDonald, of the Montreal Street Railway Company, are being built for trial in Chicago, Buffalo, New York City, Cleveland and Detroit. They have large rear platforms, divided by an L-shaped partition from the steps to the car body; the exit is short and convenient, and the entrance space affords room for about 20 passengers to stand while paying their fares to the conductor, who stands in the corner of the L. There are separate doors between the interior and the platform for entering and leaving passengers. Thus no passengers can get in without paying fares, and loading and unloading can be carried on at the same time; also the conductor is always in sight of the car steps, avoiding accidents from premature starting of the car. The system is said to be very successful in Montreal.

A Variable-speed and Feed Mechanism

By T. M. Lowthian

The accompanying illustrations show in detail a new device for obtaining a multiplicity of changes for either speed or feed gears. The gear wheels are arranged in such a way that, at one time, two of the sets of wheels will act as drivers and the other two sets be driven; at another time, the two sets that were acting as drivers will themselves be driven by the other two sets, which latter will then act as drivers. With two sets of four wheels each, as shown in Fig. 1, 32 changes of speed can be obtained, that is, 16 in each way. By having more than four wheels in each set, say five, the number of changes will be 50, and so on.

Referring to Fig. 1, A_1 is the driving shaft driven by the wheel A_2; A_3 is the driven shaft for transferring the motion to the machine through the wheel A_4. The sets of gears T and T_3 are mounted loosely on the shaft A_1. The screws $E\,E_1$ keep them in position endwise. Any one of the gears in the sets T_1 and T_2 may be connected at will to the shaft B_1 by means of the spring keys, as shown.

When the lever C is moved to the left (fine), the gear K is clutched to the set of gears T_3, and the shaft A_1 is clutched to the set T, which is then the driving set and transmits motion through the sets T_1 and T_2 to the set T_3, thence through the gears K and N to the shaft A_3. When the lever C is moved to the right (coarse), the gear K is clutched to the set of gears T, and the shaft A_1 is clutched to the set T_3, which then becomes the driving set, and transmits motion through the sets T_2 and T_1 to the set T, thence through the gears K and N to the shaft C, as before.

The four half clutches H, H_1, L and L_1 are movable endwise on the shaft A_1. They are all operated from the lever C, as shown, and also at the same time. The teeth on the two clutches $F\,H$ and $F_1\,H_1$ at the outer ends of each set of gear wheels are longer than those on the two clutches $L\,M$ and $L_1\,M_1$ at the inner ends of the sets. This is in order that one of the clutches $F\,H$ or $F_1\,H_1$ may be engaged quickly, and then, by continuing the movement of the operating lever C, one of the clutches $L\,M$ or $L_1\,M_1$ may be thrown into engagement.

A tabulated list shown by Fig. 2 is attached to the machine to show the required position of each of the levers A, B and C for obtaining the required variation of speed or feed. A correct geometrical progression is also shown for the purpose of comparison.

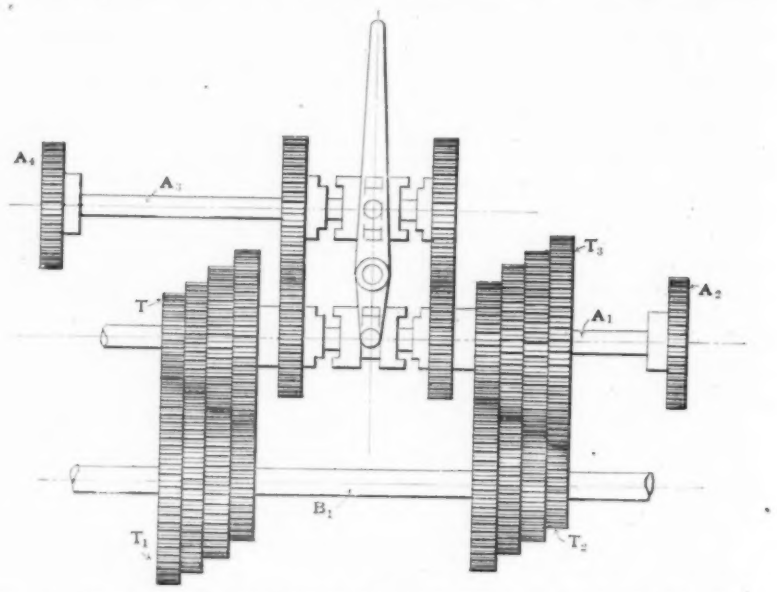


FIG. 2. ALTERNATE ARRANGEMENT OF CLUTCHES FOR VARIABLE SPEED AND FEED MECHANISM

Method of Calculation

A set of these gears will be worked out as an illustrative example. All that is necessary is to fix on the desired range of variation and the number of teeth in the smallest gears in the set. Let us take

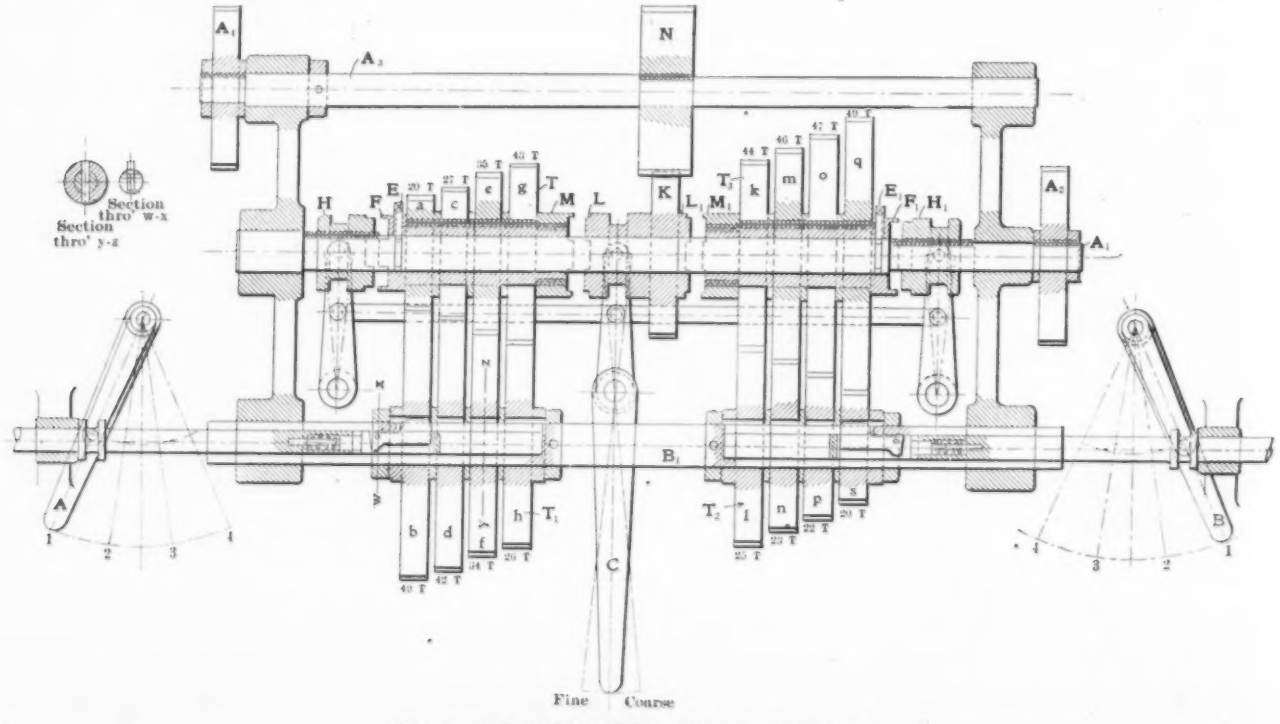


FIG. 1. A VARIABLE SPEED AND FEED MECHANISM

the case of a feed-gear box for a milling machine with a set of feeds varying from ½ inch to 18 inches per minute, arranged in geometrical progression. Also assume the ratio of the gears between the change-speed gear and the machine to be 3 to 1; then the required value of the different trains of gears will vary from ⅓ of ½ inch to ⅓ of 18 inches, or 1/6 to 6.

As the smallest gears in the set will sometimes be driven, the number of teeth must not be too small. These we will fix at 20 teeth as a minimum. Assuming the first speed to be S, and r equal to the ratio of progression, then $\frac{a}{b} = \frac{S}{q}$ and for the speeds to be in geometrical progression we must have:

$$\left(Note: \frac{a}{b} = \frac{S}{q}.\right)$$

So.

$$1. \frac{a}{b} \times \frac{S}{q} = S.$$

Wheels in Gear.	Position of Handle.		Feed Traverse in Inches Per Minute When Handle C is in Position.		Correct Geometrical Progression.	
	A	B	Fine.	Coarse.		
20 × 20	1	1	0.5	18.0	0.5	18.0
20 × 28	1	2	0.57	15.7	0.56	16.03
20 × 34	1	3	0.61	14.7	0.63	14.28
20 × 40	1	4	0.69	12.93	0.70	12.72
28 × 20	2	1	0.78	11.43	0.80	11.33
28 × 28	2	2	0.9	9.96	0.89	10.09
28 × 34	2	3	0.96	9.3	1.0	8.99
28 × 40	2	4	1.09	8.2	1.12	8.01
34 × 20	3	1	1.26	7.1	1.26	7.07
34 × 28	3	2	1.43	6.22	1.41	6.36
34 × 34	3	3	1.55	5.8	1.58	5.61
34 × 40	3	4	1.76	5.0	1.78	5.04
40 × 20	4	1	2.02	4.4	2.0	4.49
40 × 28	4	2	2.31	3.9	2.23	4.0
40 × 34	4	3	2.48	3.6	2.52	3.56
40 × 40	4	4	2.82	3.18	2.83	3.17

FIG. 2. TABLE OF FEEDS OBTAINED BY VARIABLE FEED MECHANISM.

$$2. \frac{a}{b} \times \frac{p}{o} = S \times r \; ; \therefore \frac{p}{o} = \frac{a}{b} \times r$$

$$3. \frac{a}{b} \times \frac{n}{m} = S \times r^2 \; ; \therefore \frac{n}{m} = \frac{a}{b} \times r^2.$$

$$4. \frac{a}{b} \times \frac{l}{k} = S \times r^3 \; ; \therefore \frac{l}{k} = \frac{a}{b} \times r^3.$$

$$5. \frac{c}{d} \times \frac{S}{q} = S = r^4 \; ; \therefore \frac{c}{d} = \frac{a}{b} \times r^4.$$

$$6. \frac{c}{d} \times \frac{p}{o} = S \times r^5.$$

$$7. \frac{c}{d} \times \frac{n}{m} = S \times r^6.$$

$$8. \frac{c}{d} \times \frac{l}{k} = S \times r^7.$$

$$9. \frac{e}{f} \times \frac{S}{q} = S \times r^8 \; ; \therefore \frac{e}{f} = \frac{a}{b} \times r^8$$

$$10. \frac{e}{f} \times \frac{p}{o} = S \times r^9.$$

$$11. \frac{e}{f} \times \frac{n}{m} = S \times r^{10}.$$

$$12. \frac{e}{f} \times \frac{l}{k} = S \times r^{11}.$$

$$13. \frac{g}{h} \times \frac{S}{q} = S \times r^{12} \; ; \therefore \frac{g}{h} = \frac{a}{b} \times r^{12}.$$

$$14. \frac{g}{h} \times \frac{p}{o} = S \times r^{13}.$$

$$15. \frac{g}{h} \times \frac{n}{m} = S \times r^{14}.$$

$$16. \frac{g}{h} \times \frac{l}{k} = S \times r^{15}.$$

As these 16 numbers are now in geometrical progression, so also are their reciprocals, which give the remaining 16 speeds of the progression. Then to obtain our required ratio of 1/6 to 6, $\frac{a}{b} \times \frac{S}{q}$ must equal 1/6; its reciprocal $\frac{q}{S} \times \frac{b}{a}$ must equal 6.

Substituting 20 for a and S, we have:

$$\frac{20}{b} \times \frac{20}{q} : \frac{h}{20} \times \frac{q}{20} :: 1/6 : 6$$

$$\therefore \frac{400 \times 6}{b \times q} = \frac{b \times q}{6 \times 400},$$

and

$$(b\,q)^2 = 400^2 \times 6^2.$$

Whence $b\,q = 400 \times 6 = 2400$. As b must equal q, $\sqrt{2400} = 49 = b$ or q.

Now $r = 1.123$ and $log.\ r = 0.050203$,

$$\frac{a}{b} = \frac{20}{49} \text{ and } log.\ \frac{20}{49} = 1.618.$$

We can now find from the above the ratios between the gears which mesh. Taking the second pair of gears, $\frac{p}{o}$ which equals $\frac{a}{b} \times r$ as already given, then $\frac{p}{o} = \frac{20}{49} \times 1.123$,

or

$$\frac{p}{o} = 0.4584 \text{ (and } p + o = 69); \text{ therefore, } o = \frac{69}{1.4584} = 47 \text{ nearly,}$$

Similarly

$$\frac{n}{m} = 0.5142; \text{ therefore, } m = 46,$$

$$\frac{l}{k} = 0.5773; \text{ therefore, } k = 44,$$

$$\frac{c}{d} = 0.6480; \text{ therefore, } d = 42,$$

$$\frac{e}{f} = 1.029; \text{ therefore, } f = 34, \text{ and}$$

$$\frac{g}{h} = 1.634; \text{ therefore, } h = 26.$$

And p, n, l, c, e and g will have respectively 22, 23, 25, 27, 35 and 43 teeth.

Fig. 3, which is self-explanatory, shows an alternate method of arranging the clutches. The reference letters are the same as those shown in Fig. 1.

A Problem in Differential Gearing

By C. C. Stutz

From the illustration Fig. 1 it will be seen that the pulley or gear P carries a loose stud on the ends of which are fixed the gears B and C. The gear A, which meshes with B, is fixed to the machine and does not move. The pulley or gear P in rotating carries with it the stud with the gears B and C. The latter meshes with the gear D, which is free to move, but is fast to its shaft and thus rotates the shaft with it.

Thus A is fixed to the frame and is without motion,

B is the driven pinion on the stud

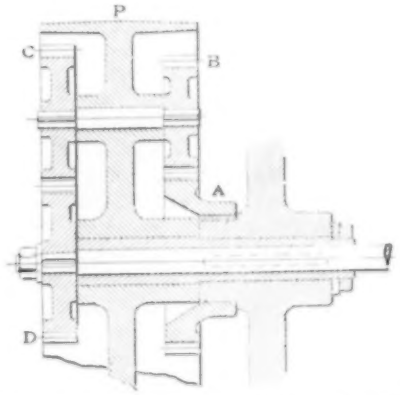


FIG. 1. A PROBLEM IN DIFFERENTIAL GEARING

C is the driving pinion on the stud and

D is the driven gear and is the last gear in the train.

According to different combination of diameters of the gears A, B, C and D, the last gear in the train, D, will move either in the same direction as the pulley P or in the opposite direction. The two diagrams, Figs. 2 and 3, show that the direction of rotation of the gear D depends upon the relative ratios of the two gears A and D.

From a further examination of Figs. 2 and 3 we find: If D has a larger pitch diameter than A it has a + motion; while if D has a smaller pitch diameter than A it has a — motion. The diameter or number of teeth of the gears B and C do not influence *the direction* of rotation of D.

In a train of gearing of the above description two questions may be asked.

1. Given the number of teeth of the four gears, in what direction will the gear D move and how many revolutions will it make to one revolution of P?

2. Given the number of revolutions of the gear P, how are the four gears to be

proportioned to obtain the desired number of revolutions of the gear D and a given direction of rotation relative to P?

CASE 1.

Assume the following conditions:

$A = 30$ teeth, $C = 24$ teeth,
$B = 20$ teeth, $D = 40$ teeth.

In one turn of P the gear B has advanced 30 teeth. As it has 20 teeth it has

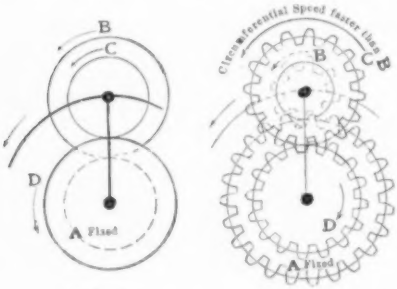


FIG. 2 FIG. 3

DIAGRAMS SHOWING DIRECTIONS OF MOTION

made $\frac{30}{20} = 1\frac{1}{2}$ revolutions. The gear C, which is fast to the same stud, also makes $1\frac{1}{2}$ revolutions. As it has 24 teeth it advances $\frac{30}{20} \times 24 = 36$ teeth to one revolution of P. If we assume that C is fast to the pulley P then the same teeth of C would always remain in mesh and D would move 40 teeth or one revolution to every revolution of the pulley P. But in our example C moves 36 teeth; that is, less than it would have moved had C remained fixed to the pulley P. We have consequently, as the motion for D, $40 - 36 = T$ to one revolution of P, or $\frac{4}{40} = \frac{1}{10}$ revolution of D to 1 of P.

The foregoing may be briefly expressed thus:

Let n = the number of teeth which the last gear in the train moves to *one* revolution of P.

Then

$$D - \frac{A\,C}{B} = \pm n.$$

According to the value n (whether + or −) the gear D moves in the same or the opposite direction with the motion of P.

Examples:

$A = 40$ teeth, $C = 28$ teeth,
$B = 24$ teeth, $D = 24$ teeth.

and

$$D - \frac{A\,C}{B} = \pm n.$$

$$24 - \frac{40 \times 28}{24} = -22\tfrac{2}{3},$$

or $\frac{22\frac{2}{3}}{24}$ of 1 revolution $= -0.944$ revolution to one revolution of A and in the opposite direction.

Again $A = 50$ teeth, $C = 30$ teeth,
$B = 31$ teeth, $D = 51$ teeth.

and

$$D - \frac{A\,C}{B} = \pm n;$$

$$51 - \frac{50 \times 30}{31} = +2.62;$$

or

$$\frac{2.62}{+\ 50} = +\ 0.0524 \text{ revolution.}$$

Thus D moves 0.0524 revolution to one revolution of A and in the same direction.

CASE 2.

Let us assume:
Revolutions per minute of $P = 300$.
Revolutions per minute of $D = 60$.
The direction of rotation of B is + .
The number of teeth of $D = 30$.
Then we have

One revolution of $P = \frac{60}{300} = 1/5$ revolution of D or, to 1 revolution of P, D moves 1/5 of 30 or 6 teeth.

According to Case 1 the following relation must exist between the four gears A, B, C and D:

$$D - \frac{A \times C}{B} = \pm n,$$

or

$$30 - \frac{A \times C}{B} = +6.$$

Furthermore gear D must be larger than gear A to obtain the + direction of rotation.

Assuming that $A = 20$ teeth, we have

$$30 - \frac{20 \times C}{B} = 6.$$

We will have to find values for B and C by cut-and-try methods. By this means we find

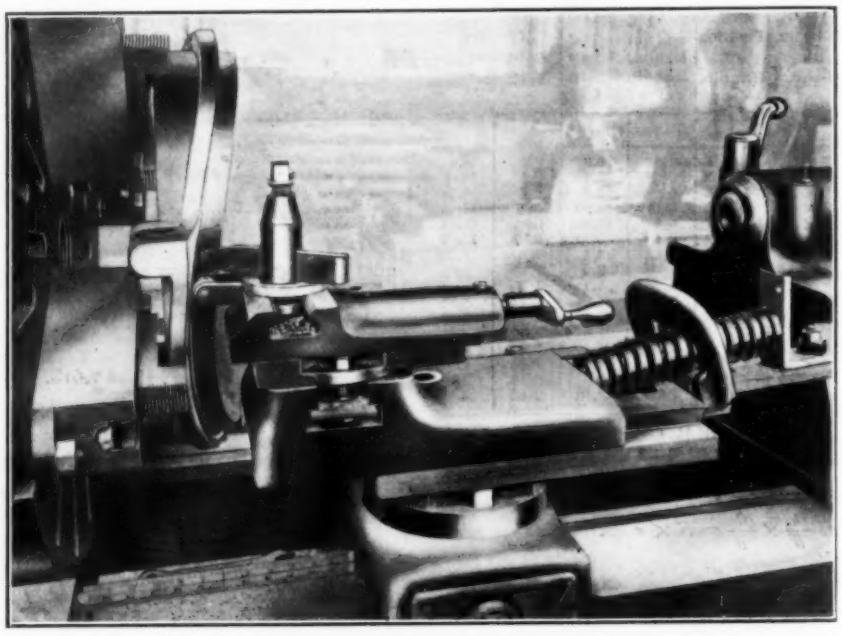
$B = 20$ teeth and $C = 24$ teeth.

A Device for Turning the Irregular Surface of a Large Air Port

BY H. A. EVANS

The half-tone illustration shows an arrangement used to turn a surface of an irregular casting. The casting is shown clamped to the face plate of the lathe and with the tool at work. It is a large air port of irregular shape, made to fit the vessel in which it was to be placed.

The device needs little explanation. The compound rest of the lathe was allowed to slide freely. Just below the cutting tool a holder carrying a roller was fastened in such a position that the roller rested against the irregular vertical flange of the casting. Behind the rest was clamped a spring which forced the rest toward the work and kept the roller in contact with it. As the casting rotated, this roller moved the tool in a path parallel to the vertical flange. This device was used at the Mare Island navy yard.



TURNING RIG FOR A LARGE IRREGULARLY SHAPED AIR-PORT

A Kansas farmer, A. S. Wysong, has, according to *The Automobile*, made for himself a mechanical horse which will plow six furrows at once, or can be used at a higher speed (6 miles per hour) to draw a train of wagons along the road, and can also be used as a portable engine to run machinery; it weighs 4100 pounds and was made by mounting a 30 horse-power gasolene engine on wheels. He has plowed 30 acres of land in a day with 50 gallons of gasolene for fuel, and it is claimed alcohol or kerosene may also be used.

Economies and Advantages of Grinding—I

By Selecting the Proper Wheels, Keeping Them in Good Condition and Using Them at the Right Pressure and Speed

BY H. DARBYSHIRE*

If any proof were wanted of the growing popularity of the grinding machine it may be found, not alone in the general recognition of its value as at present constructed, but also in the many inquiries for machines for specific purposes where either accuracy or a superior finished surface is desirable. From an economic point of view it is an established fact that it is cheaper to finish by grinding than by other machinery methods, even for the crudest class of machinery; and we may take mining and agricultural machinery as instances where it is found to give profitable results. Purchasers of machinery are becoming more exacting in their requirements and, being somewhat conversant with what is possible with modern methods of manufacture, they look disparagingly on what would have formerly been considered good practice.

The first consideration in the design of any machine must of course be the one of utility and ease of manipulation, combined with due provision for its economic manufacture. Here the work of the designer may be said to end and it rests with the manufacturing department to further his aims, that is, to build up as cheaply as possible a durable and salable specimen of his creation. Its durability will depend partly on the material of which it is constructed and the means employed to bring its details to the requisite shape and degree of precision; for this, nothing can excel the grinding method either for quality or economy. The outward finished appearance of the machine must also be considered, for its condition in this respect may be taken as an index of the quality of the work within; thus a coat of paint may be a means of hiding many defects that are by no means detrimental on a surface that has been machined, but a bright surface finish is more acceptable when it has been obtained by the process of machine grinding.

Costs Less Than Hand Labor

There is much good reason in the argument against putting in any unnecessary work in a machine, but after all this mostly refers to the expense incurred in finishing visible parts for the sake of appearance; when nothing but hand labor is available the argument is justified, for to get anything beyond a slovenly job means an expenditure of much time and labor. Grinding on the contrary is a mechanical process which can only be conducted with a minimum of error as compared with hand labor, and the beauty and symmetry of its finish is obtained at less cost than the latter.

Every example of the machine builders' art consists, when unassembled, of a number of details which mostly take the form of planes or cylinders, and to bring these to the required degree of accuracy has necessitated in many cases the cost of highly skilled labor. To obtain the utmost value from this labor is the duty and should be the ambition of every workshop management, and though the purchase and installation of modern machinery is to be commended, it is by no means sufficient. Effort should be made and vigilance exercised in seeing that any new type of machine maintains its guaranteed output in every case; for should this vigilance ever be relaxed, heavy and unnoticed losses may occur. These remarks may well apply more especially to grinding machines as being tools which are not so generally understood nor their economic possibilities appreciated, also to the fact that the so-called difficulties attending their efficient maintenance are much exaggerated. On the other hand there are many exaggerated ideas prevalent as to their capacity, which may easily lead to a costly and unnoticed expenditure. In this abbreviated matter some effort will be made to dispel the doubts of the skeptical and to moderate the expectations of the more sanguine, while it is also possible that some light may be shown on the difficulties encountered in running a grinding plant.

The Greatest Obstacle

Probably the greatest obstacle to a universal adoption of grinding processes is the difficulty of obtaining suitable grinding wheels, yet their selection would seem to be a very simple matter. Improvements in abrasive wheels have kept pace with the development of the grinding machine, yet there is a marked lack of modern literature or instruction on the subject. For this both grinding machine and wheel makers are much to blame and even where treatises are provided they would be much improved by being more explicit and up-to-date. On the other hand users of grinding machinery should learn to think for themselves and not place too much reliance on the wheel salesman, as he is generally an individual without practical experience, whose prime object is selling and who can only recommend a wheel from what he has heard of its performance in some individual case, which might easily be quite opposed to the conditions under which the purchaser requires to use it and which will be explained later on.

There are many peculiar phenomena which take place in the action of abrasive material that are difficult to account for and for which a mere superficial observation is insufficient. The want of a standard method of grading, which should not be impossible to establish, leads to a confusion of ideas on the whole subject which would seem to be quite unnecessary if wheelmakers would coöperate to provide for it. Grinding processes now enter so largely into our industrial arts that the whole matter deserves a full and scientific analysis and is an opportunity for our universities to make interesting and useful research; meanwhile until something of the kind is done, there will always be the matter of prejudice to combat and the writer is quite conscious that he may be easily charged with this failing in the matter here put forward.

The Commercial Abrasives

Emery, corundum, carborundum and alundum are the ordinary commercial abrasive materials, and even sandstone wheels have still their advocates for use in machine grinding. Apart from prejudice the use of the latter for this purpose at the present day is difficult to understand and the only virtue claimed for them is that they do not so easily draw the temper of high-grade steels. On the other hand they cut slowly and are far more costly than the built-up wheel, which will answer the same purposes if a proper selection be made. The four prime abrasives which have been mentioned vary in hardness, though it does not follow that the hardest grit is the best for cutting purposes; the shape and form of fracture of the particles must also be taken into consideration. We may imagine a wheel made up from diamonds, the hardest substance in nature, and whose individual kernels were of spherical form; it is quite obvious that it would be of little service as a cutting agent; on the other hand if these kernels were crystalline or conchoidal in form it would probably be the ideal grinding wheel.

Emery is an impure form of corundum containing an average of 40 per cent. of oxide of iron; it is of a tough consistency and breaks with a conchoidal fracture; although it is rapidly being displaced by corundum and the artificial abrasives it is still much in favor for the grinding of hardened steel, mostly on account of the superior finish it leaves. This may be accounted for by the fact of its being the

*European instructing operator for the Norton Grinding Company.

softest of the four abrasive materials; therefore it is the more quickly dulled and glazed when light skin cuts are taken. It is, on the whole, an efficient cutting material, but for lack of durability it loses its size rapidly as compared with corundum or alundum.

Corundum is an oxide of aluminum of a somewhat variable purity according to the neighborhood in which it is mined; its fracture is conchoidal and generally crystalline. It is superior to emery as far as durability is concerned and cuts sharper; to obtain a similar finish on very hard material a wheel of this material must be made of a somewhat finer grit than one made of emery; or as an alternative it must be turned more smoothly with the diamond tool.

The Hardest Abrasive Known

Carborundum is a silicide of carbon and is a product of the electric furnace; it is probably the hardest abrasive known and breaks with a sharp crystalline fracture. Owing to its exceeding sharpness and ease of penetration it is most useful on the softer materials such as brass, marble, granite and in its finer grits for cast iron. On hard steel, however, it does not show the same relative efficiency as emery, which is the far softer abrasive; this is a marked instance of the eccentricity of abrasive materials and is difficult to account for. Carborundum, though exceedingly hard, is very brittle and it would seem as if the points of its crystals are constantly breaking when in contact with hard materials. In the finer-grit wheels it gives an excellent finish if allowed to glaze and this without excessive pressure, more especially on hardened steel. One of its great disadvantages is that it causes excessive wear of the diamond truing tool, owing to its exceeding hardness.

Alundum is an artificial product, being a fused oxide of aluminum. It is of uniform quality with about 98 per cent. of purity. It breaks with a sharp, conchoidal crystalline fracture and has all the toughness of emery. It is probably not so hard as pure corundum but is certainly harder than the average marketable commodity and has the advantage of being less brittle. This latter quality makes it the superior abrasive for the grinding of hardened steel and its ease of penetration and durability make it equally of service on the softer materials. Taking all its merits into consideration, it is probably the most valuable of all abrasives for the general purposes of the engineer.

Choosing Suitable Wheels

We now come to the question of choosing suitable wheels for various materials and processes of machine grinding, and here comes the difficulty and want of a standard and of a universal method of grading. Of the many firms engaged in the manufacture of grinding wheels there are probably no two which have a similar method of grading or designating the hardness of their wheels. The Norton Company, which is probably the oldest in the field, uses the letter method, which may be said to be the simplest. That is, they take M for their medium-hard wheel and the letters before M denote in regular alphabetical progression the progressively softer wheels. Moreover they use a + mark for denoting wheels which vary in temper from the standards. Thus a wheel may be harder than the standard K, let us say, and still be not so hard as the standard L; in this case it is known as K+. The Carborundum Company adopts a somewhat similar method of grading, the difference being that although M denotes its medium-hard wheel the letters before M denote the progressively harder grades. Various other American companies use the letter method of grading to some extent, but all have individual ideas as to what degree of hardness should constitute an M or medium-grade wheel. Then we have firms both in America and on the continent of Europe which discard the letter method of grading or else use it in conjunction with numbers or fractions of numbers such as 2H, 1½M and so on. All this is bewildering to the user of wheels and constantly gets him into difficulty. It very often happens that the maker and user are separated by long distances and the changing or obtaining of a suitable wheel means long delays and consequent loss.

The doubtful advantage to the wheelmaker of this state of chaos is that when a customer is educated to his especial method of grading he will hesitate at trying his competitors' wares for fear of the trouble and confusion that may arise. But there is another side to the question. The writer knows of many instances where engineers are either conscious of the value of grinding processes or have ventured on the installation of a small plant, but the trouble with wheels has on the one hand made them afraid to commence the practice, and on the other it has either fallen into abeyance or not been carried out to the extent it seemed to deserve for the reasons stated.

Standard Grading of Wheels

Individual enterprise would seem to show that firms would come into line with a standard and international method of grading, as may be gathered from the following instance, which is not uncommon. A firm of continental wheelmakers found that its sales were much restricted by its cabalistic method of grading when dealing with people who used the Norton wheel exclusively. As a simple matter of business they procured samples of most of the Norton wheels and compared them with their own for hardness. The result was a circular issued to the firms interested, the substance of which was a comparative table showing how its wheel compared with the Norton.

The selection of suitable wheels for machine grinding may be said to be governed by the following points, namely, the texture of the material to be ground, the arc of wheel contact with work and the quality of finish required. The first and last of these points can for convenience' sake be taken in conjunction, and here let it be understood that the quality of surface finish is dependent on the condition of the wheel face and depth of cut rather than on the fineness of the grit in the wheel. To make it still more clear, a wheel of so fine a grit as 100 will give an indifferent finish if it be not turned true and smooth.

It may be assumed that for all general purposes the aim in view is to procure a wheel which will fulfil two conditions, that is, that it shall first remove stock rapidly and at the same time give a decent finish. Wheels made from a combination of grit of different sizes are the best for this purpose, as may be seen from the following explanation. Coarse wheels of an even number of grit will remove stock faster than will fine wheels of an even number, because their depth of cut or penetration is greater. They, however, fail in giving a high surface finish except in grinding very hard material, because they are not compact enough.

The Combination Grit Wheel

With the combination wheel the conditions are different and it seems better at removing stock than does the coarse, even grit wheel. It may be safe to assume from this that something of a *grindstone action* takes place, that is, that the finer particles of grit become detached from the bond and both roll and cut in their imprisoned condition between the larger particles. For finishing purposes this wheel has all the compactness and smooth face of a wheel which was made solely from its finest number of grit; and for roughing, it enables a depth of cut to be got which is within the capacity of its largest kernels.

With regard to the texture or hardness of material ground it may be taken as a general rule that the harder the material is, the softer the bond of wheel should be and that cast iron and hardened steel bear some relation to each other as far as grinding wheels are concerned, for the same wheel is usually suitable for both materials.

Too large an assortment of wheels is likely to lead to confusion, and we may take the Norton plain cylindrical grinding machine as being a case in point of a limited assortment of wheels; at the same time it will be a starting point to illustrate choice of wheels under various grinding conditions. In this machine four different grade wheels, all of 24 combination grit, are found sufficient for all classes of material that it is ordinarily required to grind. This includes high- and low-carbon steels, cast iron, chilled iron, and bronze

or composition metals. These wheels are graded J, K, L and M, and even the hardest of these, M, is superfluous. A 24 M wheel is only suitable for the softest of machine steels, yet it has to be supplied as an antidote to ignorance, prejudice and want of experience. It is generally called for in the belief that it lasts longer and so does more work than its next softer grade, though this need not necessarily be so. A wheel that is too hard must be repeatedly dressed with the diamond, which is one way of wearing it out, and diamonds themselves are expensive enough to be a consideration.

One Advantage of Grinding

One of the greatest advantages accruing from grinding is that it ignores the non-homogeneity of material and that it machines work with the lightest known method of tool pressure, thus avoiding all those deflections and distortions of material which are a natural result of the more severe machining processes. Yet these objects are too often defeated by the craze for hard and long lived wheels. A wheel that is too hard or whose bond will not crumble sufficiently under the pressure of cut will displace the work and give rise to many unforeseen troubles. It is also a prolific cause of vibration which is antagonistic to good and accurate work. The advantage claimed for it, that it gives a better surafce finish, is a deceptive one, for it mostly obtains this finish at the expense of accuracy. Quality of finish, that is, accurate finish, is merely a question of arranging of work speed, condition of wheel face and depth of cut. In the machine mentioned the suitability of wheels to materials and conditions is found to be as follows, the wheels being in each case of a combination of alundum grit:

For hard drilled iron and large diameters of cast iron and hardened steel	24 J
For medium chilled iron and medium diameters of cast iron and hardened steel and bronze	24 K
For all grades of steel which are not hardened and for bronze	24 L
For very low carbon machine steels.	24 M

The table given may, speaking generally, be what would be chosen in the way of wheels for the materials given, and in actual practice they soon give evidence as to whether they are suitable. It may be gathered from the table that diameter of work is a factor in the choice of a wheel. This refers to area of wheel contact and is governed by what is shown in the table when broad differences of diameter occur; for instance, it might be necessary to use the K wheel for a large diameter of high carbon steel if the L wheel was evidently too hard. One great reason for the success of the Norton machine is the practice of using the softer bonded wheels together with provisional points in its design, such as its massive construction and the wheels employed tend to obviate vibration. Soft wheels require that the work shall revolve slowly and this is compensated for by the broad wheel face and its rapid and easily controlled side feed; its wheels run at a constant speed, and are limited in number and variety, so that its numerous and rapidly arranged changes of work speed are an absolute necessity apart from their other economical advantages. These numerous changes of work speed enable the efficient cutting of any given wheel under broader conditions than would be otherwise possible, so that one wheel answers a number of purposes. At the same time the quality of finish is mostly dependent on work speed and its provision for rapid changes of these is at once apparent. When once the method of grading of a line of wheels be understood, their selection for all ordinary purposes is a simple matter if a little reasoning be indulged in.

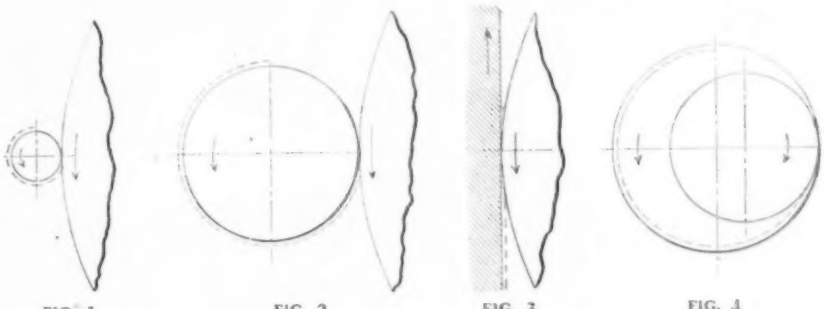


FIG. 1 Grinding Small Dia.

FIG. 2 Grinding Large Dia

FIG. 3 Grinding Flat Surface

FIG. 4 Internal Grinding

WHEEL CONTACT WITH DIFFERENT WORK

Speed and Efficient Cutting

The efficient cutting of a wheel depends very much on the speed of the work, and an absence of knowledge in this respect may often lead to a suitable wheel's rejection. Revolving the wheel at the speed recommended by the maker is the first necessity, and if it is found unsuitable after experimenting with various speeds it should be changed for a softer or harder one as the conditions indicate. Starting from the point that a wheel is desired that shall remove the maximum amount of stock with the minimum amount of wear on the wheel, the indications and method of procedure may be as follows; only it must be understood that this refers to cases where an ample supply of water is being delivered at the *grinding point.*

If after trying all reasonable work speeds, a wheel should burn the work, or refuse to cut without excessive pressure, or persistently glaze the surface of the work, it is too hard for that particular work and material and may be safely rejected. If after trying all reasonably reduced work speeds, a wheel should lose its size quickly and show all signs of rapid wear, it is too soft for that particular work and material and may be rejected. These indications refer to all ordinary cases and it may be gathered that the most economical wheel is that which acts in such a manner as to be a medium between the two cases. There is still another point to bear in mind with regard to the size of the grit in the wheel, but which refers more especially to very hard materials such as chilled iron. Either a coarse or combination wheel may go on cutting efficiently in roughing cuts because pressure is exerted, but may begin to glaze when this pressure is much relieved as in finishing cuts. A careful microscopic scrutiny of a wheel that displays this tendency would seem to lead to the following assumption:

When a Wheel Is Sharp

The wheel face when newly trued with the diamond tool, which is necessary to obtain an accurate finish, shows a promiscuous arrangement of particles, some of which present points and others present a broader face with a rough and granular surface. When the wheel is presented to the hard surface of the work the high points of this granular face and the sharp contour of the kernels will go on cutting until they are dulled and worn down, after which their face area is too great to enter the surface without undue pressure. When the wheel has reached this condition the microscope shows these broader-faced kernels polished to a metallic luster, which bears out the explanation tendered and also makes the remedy quite apparent. This is to use a wheel of very fine grit for finishing purposes in these cases or else keep the coarser wheel in condition by repeated dressings with the diamond tool.

We now come to the question of wheel contact, and will take two extreme cases to illustrate how misunderstandings can easily, and often do, exist. A wheel may be asked for that is suitable for grinding machine steel, and the wheel agent or salesman offers one that has some reputation for efficiency in grinding that material. It may be that its reputation has been earned in the grinding of steel shafts of from small to medium diameter, and that the purpose for which it is asked for is the grinding of flat steel strips of precisely the same material, yet for this purpose the wheel would almost certainly be

unsuitable and would require to be of a softer bond or grade.

A reference to Figs. 1 to 4 will show what actual practice requires in the choice of a wheel as far as the question of wheel contact is concerned. A wheel is shown in contact with four different varieties of work, all of which we will suppose to be of the same material, the depth of cut, much exaggerated, being the same in each case. In the first case it is a shaft of small diameter, and the wheel contact being the smallest the harder grade of wheel would be suitable, comparatively speaking. Assuming that this wheel was found to be suitable it would probably require a softer wheel for the next case, which is a shaft of larger diameter, and the wheel contact proportionately greater. To continue the comparison still further the third case shows the wheel engaged in grinding a flat surface, and the fourth is a wheel grinding internally. In each case practice demands that the wheel shall be progressively softer in bond or grade and is some proof of a consistency in the action of grinding wheels.

The Contact Area of Wheel

The most probable explanation of this may be that as the contact area increases more work is required from each individual kernel of grit and it the sooner becomes dulled; this requires that the bond must be more friable both to allow it to escape easily and to minimize the pressure required to make the wheel cut as the cutting area becomes greater. Following on this reasoning we are able to choose a list of wheels which would be suitable for almost all purposes, and which would be as follows if of Norton grade:

For plain cylindrical grinding
J K L M
For grinding plane surfaces
H I J K
For internal grinding
F H I J

This collection of wheels would be suitable for almost any type of grinding machine, though when the wheels are exceptionally narrow a grade or one-half grade higher might be possible; it would, of course, be a matter for a little trial and experiment. The wheels for external cylindrical work may preferably be combination wheels, but for plane surface and internal work they are better made of single grit, about 36 or 46. The great contact area of wheel in these two classes of work is liable to generate much heat so that an open and porous wheel is preferable. The method of reasoning in choosing a wheel here advised is one that has served the writer in some few years of experience, and the Norton method of grading has been chosen for illustration because it is considered the simplest and most generally understood; the same line of reasoning, however, would serve with any other method of grading when the wheel user became conversant with it.

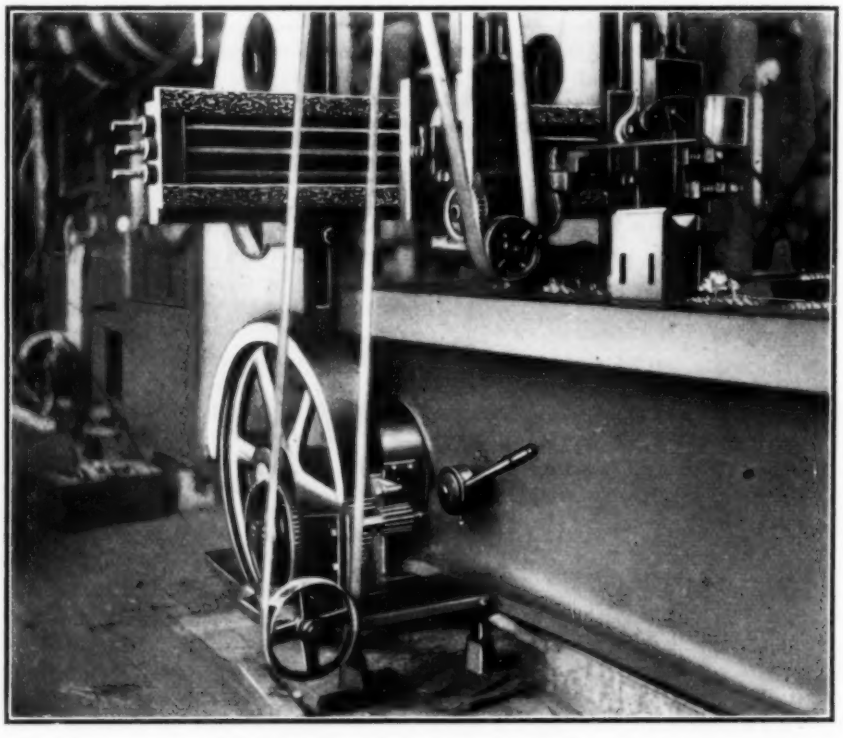
Briefly speaking, the matter of wheels being true to the symbol of grade that they represent, and the ability of their maker to duplicate them are of equal or greater importance than their prime constituents. It goes without saying that they should be both balanced and homogeneous in their construction, all of which are points for the user's consideration when placing his orders. Finally, avoid hard wheels above all things, and don't get the idea that their long life or promise of the same is an economic advantage; rather educate yourself to the use of soft wheels with work speeds and other conditions to suit them, and your grinding will prove of better quality with less aggregate cost. Having now arrived at the point where suitable wheels have been procured, we may next take their economic use into consideration, and here let us consider for a moment what the wheel really is.

The litigation on the Selden patent recently led to some interesting demonstrations in the automobile district on Broadway, New York. The old Selden buggy of 1877 was run up and down to prove that it *would* operate, both on flame and electrical spark ignition. But though it ran some, its performances were not very brilliant, and were exceeded by those of a car built by parties on the other side; this machine had a Lenoir engine, made according to patents of 1865. Its backers offered to give the Selden car a 45-mile start and then try to beat them in a 50-mile race, but the offer was declined.

Cutting Long Keyways

The spindle of a Binsse boring machine makes rather a long keyway to cut, and as there are two of them on opposite sides, it became quite a problem to cut them quickly.

So they rigged up the milling device shown and put it on a planer that was not used very often, as shown in the photograph. The milling attachment goes on the cross rail of the planer in the usual way and is driven by a worm as shown, from an overhead belt. The planer table is driven by another worm, shown in the foreground. The pinion on the inside end of the worm shaft slips into or out of mesh with the large gear wheel on the planer. This allows the planer to be used for regular work without moving anything but this pinion and the milling head on the cross rail.



MILLING ATTACHMENT FOR PLANER

A rig of this kind can be easily made where conditions warrant it, and the results in this case show that it is a money saver in this shop. The time taken to plane these keyways was about 10 hours for two 12-foot lengths, while with this they are milled at the rate of 12 feet per hour and require but one cut. This finishes the two keyways in 2 hours as against 10 in the other case, which is a very considerable saving.

The spindles are held between V-blocks which hold them level and firm for cutting and allow handling quite easily. This comes from the shop of the Binsse Machine Company, Newark, N. J.

F. H. C.

A Practical System of Detail Drawings

By Bruce C. McAlpine

In these days of interchangeable manufacturing it is customary, in manufacturing a standard machine, to make each detail independently and carry it in stock, drawing upon the stock room for parts as required in assembling the machine. In connection with this system of manufacturing, the detail drawing plays an important part in the machine shop. It is the purpose of this article to describe a system of detail drawings which has proved itself to be simple and effective, in the hope that it may be of interest to the readers of the American Machinist.

The works in which this system is in use are engaged in the manufacture of machine tools. The machines they produce are standardized and built in quantities. Each size of machine is designated by a letter or combination of letters; each separate detail of the machine is assigned a number, castings being numbered from 1 to 299, machinery-steel parts from 300 to 499, and tool-steel parts from 500 up. Thus S A is the symbol for a 16-inch crank shaper. The ram is designated by S A — 1, the column by S A — 2, the cross rail by S A — 3, etc. Now these numbers (S A — 1, S A — 2, etc.) are plainly marked on the piece each designates, wherever such piece occurs on an assembly drawing; also a separate detail drawing is made for each piece. These detail drawings are made on small printed forms on bond paper, 5x7 inches in size, as illustrated in Fig. 1. Each detail drawing is identified by the number of the piece which it represents. as shown in heavy underlined figures at the top of the sheet, Fig. 1.

The only requirement of these detail drawings is that they be legible and complete. Many of them can be drawn free hand, and for this purpose a drawing board is prepared, as shown in Fig. 2, with a sheet of drawing paper on which a 5x7-inch space is ruled off in ⅛-inch squares. By laying the blank form over this and fastening it with small thumb tacks, simple pieces can be easily drawn up free hand with a round-pointed pen.

For filing these detail tracings in the office, a set of pigeon holes about 1¾ inches wide by 7 inches high and 8 inches deep is provided. There is one pigeon hole for each size and style of machine built. The detail drawings are placed in numerical order, and a folder of drawing paper is placed over them to keep the corners from rolling up. This folder, with the tracings inside, is then slipped into a heavy manila envelop and placed in the pigeon hole. The method of filing is illustrated in Fig. 3.

For use in the shop, a blue print of each detail drawing is made and pasted on a 5x7-inch card. These cards are of heavy cardboard and are secured from the printing office already cut to size. These mounted prints are given a coat of shellac varnish, and placed in the shop. For filing them in the shop, a set of drawers is provided, there being one drawer for each size and style of machine built. These drawers are about 5 1/16 inches deep by 7 1/16 inches wide by 14 inches long, inside measurements.

The mounted detail drawings are placed in the drawer in numerical order, facing the front. This brings the number on each card at the top and in the center, so that any desired card can be found at once. These cards are for the purpose of handing out to the workman when assigning him a job. In this way each workman has only one drawing before him, and has that drawing all to himself. This does away with three or four men working from one blue print and reduces the liability of mistakes to a minimum. The workman hands in the drawing when his job is finished. and it is put back in the proper drawer until wanted again.

In order to facilitate looking up the detail drawing of any piece without having to hunt up the workman who has that particular card, each foreman is provided with a set of detail blue prints for each size and style of machine with which he is concerned. These blue prints are ar-

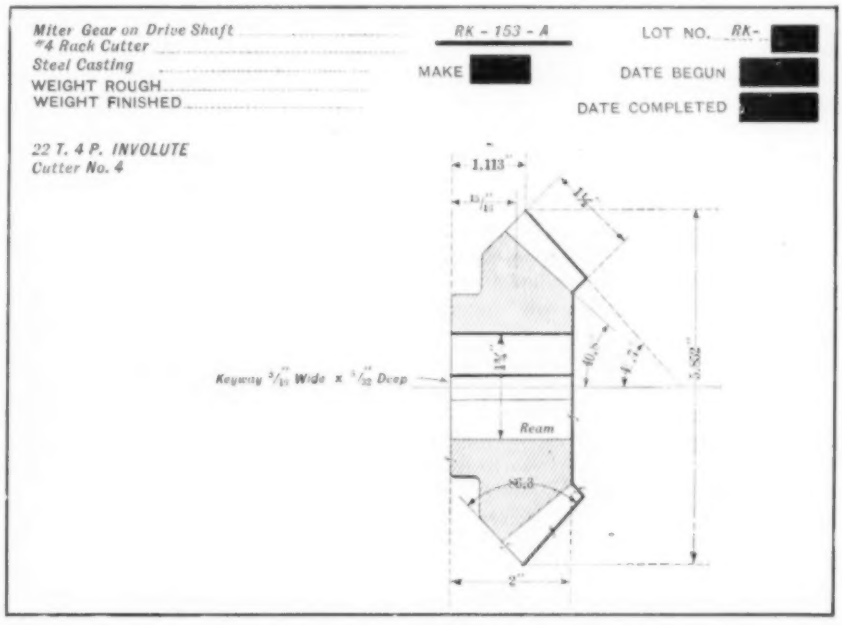


FIG. 1. PRINTED FORMS ON 5X7-INCH BOND PAPER

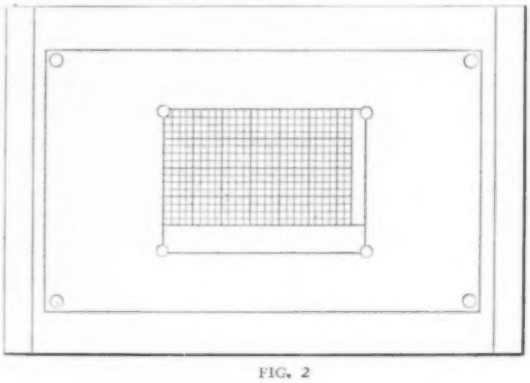


FIG. 2

RULED PAPER FOR SKETCHING

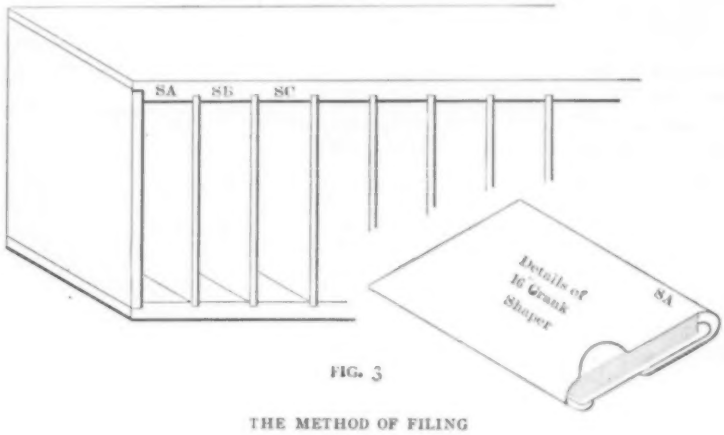


FIG. 3

THE METHOD OF FILING

ranged numerically and bound in book form, each machine in a separate cover. For the purpose of binding these blue prints, the printed forms on which the detail drawings are made have a margin of ½-inch at the left-hand edge. The blue prints are punched in this margin, covers cut out of heavy drawing paper, and the whole fastened together with twine run through the punched holes. The machine symbol and name are plainly lettered on the front cover. These books are not allowed to be left away from the foreman's desk where they belong. Therefore each foreman has always at hand a complete drawing of every piece with which he is concerned, in such shape that he can refer to it at any instant.

In order to find any detail drawing, it is convenient to know the number it carries. This may be found from an assembly drawing and is also supplied in the form of a list of parts for each style of machine, in which the various pieces are arranged in groups as they go together on the machine. For instance, the parts of an engine lathe are grouped under the headings of 1, Headstock; 2, Tailstock; 3, Carriage; 4, Apron; etc. Then to find the number of the live spindle, one would look in the headstock group, where the desired piece and its number are quickly found.

In connection with the above system of detail drawings, there is a method used for recording changes in machines, which is worthy of mention. Whenever a piece is altered, the altered piece is designated by the original number of the piece followed by a letter. For instance, if the ram S A — 1 is changed, the new style of ram is designated as S A — 1 — A, and if it is changed again it becomes S A — 1 — B, etc.

Now when a machine is changed, the assembly drawings are corrected and a note placed on them giving the date and nature of the change and a complete list of all the pieces changed, together with the number and letter each piece carries before and after the change was made. Then a new detail drawing is made for each piece which has been changed, the new drawing carrying the new suffix after the number of the piece it represents. A note is written on each old detail drawing, stating the date that it was last used and the serial number of the last machine that it was used on. The lists of parts are then corrected.

This provides a record of all changes, and does away with the necessity for filing away blue prints when a machine is changed, as all the detail drawings which have ever been used are preserved and each one carries a record of the time that it was in use.

A pewter-like appearance may be imparted to brass by boiling the castings in a cream of tartar solution containing a small amount of chloride of tin.—*Foundry.*

Strength of Bevel Gears

By Chas. H. Logue

The article on page 155, by R. Shaw, entitled "The Lewis Formula Applied to Bevel Gears," reminds me of the methods and formulas which I use for such computations.

In general I apply the Lewis formula for spur gears, figuring the safe load from the average pitch diameter, or, stated a little differently, the velocity in feet per minute is to be taken at the average pitch diameter; otherwise the gear is to be treated as a spur.

Let N = the number of teeth,
P = the circular pitch,
D' = the pitch diameter,
f = the face width,

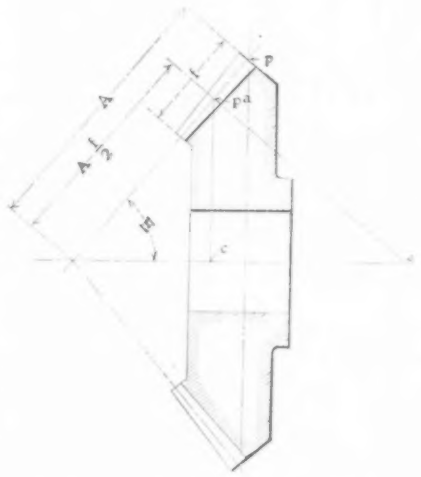


DIAGRAM FOR STRENGTH OF BEVEL GEARS

p_a = the average circular pitch,
D_a = the average pitch diameter,
A = the apex distance,
E = the center angle,
s = the safe working stress,
V_a = the velocity (average) in feet per minute.

In order to get the average pitch we must first determine the apex distance A. See the illustration.

Now

$$A = \frac{D}{2 \sin. E}.$$

The average pitch is the pitch at the center of the gear face f. Above this section the tooth strength increases and below this point it decreases. The mean strength of the tooth is, therefore, located at this point. Thus it is the proper dimension to use in determining the strength of the tooth. This average pitch is found from the following equation:

$$p_a = \frac{p\left(A - \frac{f}{2}\right)}{A}.$$

This formula is derived as follows: By referring to Fig. 1 it is evident that the pitch of the tooth at p is to the apex distance A as the pitch at p_a is to the mean apex distance $\left(A - \frac{f}{2}\right)$.

The average pitch diameter D_a is found from formula (3) by substituting the average pitch. The average velocity V_a is found from formula (4) by using the average pitch diameter. Then

(1) $A = \frac{D}{2 \sin. E}$.

(2) $p_a = \frac{p\left(A - \frac{f}{2}\right)}{A}$.

(3) $D_a = N p_a 0.3183$.

(4) $V_a = 0.2618 D_a$ (r.p.m.).

(5) $Safe\ load = s p_a f y \left(\frac{600}{600 + V_a}\right)$

(6) $Horse\text{-}power = \frac{Safe\ load \times V_a}{33{,}000}$

The values for the factor y are from the Lewis formula.

An illustrative example is as follows: What power may be transmitted by a pair of miter gears of the following dimensions: 30 teeth, 2-inch pitch, 5-inch face, 19.107-inch pitch diameter, at 50 revolutions per minute? The material is cast iron.

$A = \frac{19.107}{2 \times 0.707} = 13.51$ inches, the apex distance;

$p_a = \frac{2 \times (13.51 - \frac{5}{2})}{13\ 51} = 1.63$ inches, the average pitch;

$D_a = 30 \times 1.63 \times 0.3183 = 15.5$ inches, the average pitch diameter;

$V_a = 0.2618 \times 15.5 \times 50 = 203$, the average velocity in feet per minute;

The safe load $= 8000 \times 1.63 \times 5 \times 0.102 \times \left(\frac{600}{600 + 203}\right) = 4900$ pounds.

The horse-power $= \frac{4.900 \times 203}{33{,}000} = 30.1$.

The teeth in bevel gears are more strongly shaped than the teeth of spur gears of the same pitch and number. This increase is represented by the radius $c - p'$ in Fig. 1, compared with the radius at the point p. The corresponding number of teeth for this larger radius is found by the expression:

$$\frac{N}{\cos. E}.$$

When selecting the constant y, however, it is well to disregard this increase, as it will tend to compensate for the loss in efficiency due to the use of bevel gears.

For metal plates under one quarter inch in thickness welding is fast replacing the old method of riveting and is a much cheaper process.

Practical Letters From Our Readers

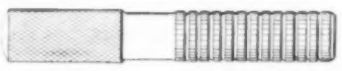
A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Drift for Producing Burs

The accompanying drawing is of a drift I made for use in repetition brazing work. The work consisted of brazing together brass tubes in which small tubes were brazed into holes drilled at right angles to the axis of a larger tube; the small tubes passed through the larger one. The tubes were fitted together in a jig which located the small tubes correctly in the holes in the larger and were then brazed on a circular table, a gas blowpipe being used. The table revolved and brought the assembled tubes under the flame.

Unless the tubes were fitted tightly together, the heat expanded the larger tube and it was liable to get misplaced. To make it a tight fit was impracticable, as it would not allow the spelter to flow. What was wanted was a "close-open" joint, which seems like a queer expression. However, I got it by means of the tool shown. To make it I nurled a piece of steel with a straight-tooth nurl of small pitch. The upper or handle part I nurled



A BROACH FOR PRODUCING BURS

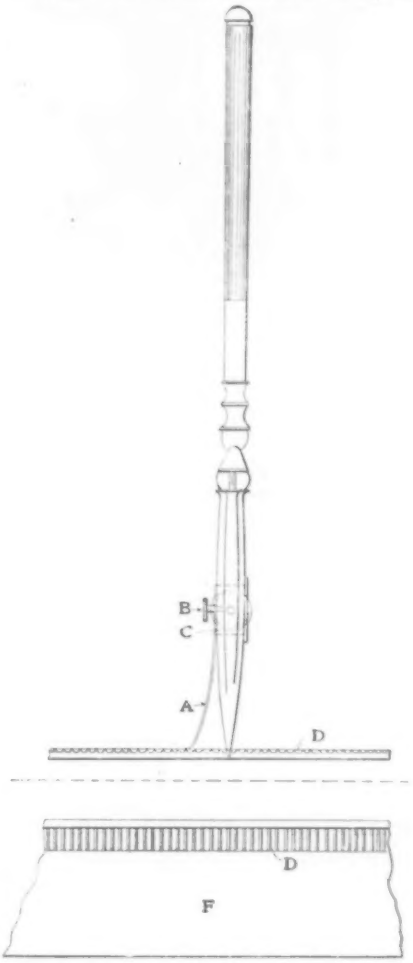
with a pair of 45-degree nurls, left and right. The straight-nurled part I grooved, ⅛-inch pitch. One side of the grooves made scraping edges facing in the direction of the bottom of the drift. The holes in the tubes were reamed about 0.002 inch larger than the tubes to fit them, which were ½ inch in diameter.

The drift was made slightly tapered to fit the holes and was then hardened and tempered. By forcing the drift into the holes slight burs were thrown up and slight grooves scraped. The diameter of the holes at the top of the bur was then smaller than the tube. It will be seen that while the points held the tubes together firmly, the slight grooves made space for the spelter to run. Again, some time often elapsed between the reaming operation and the brazing, thereby exposing the edges of the holes to oxidation. By passing the drift through previous to assembling, however, fresh metal was exposed. The burs and grooves were so slight as to be hardly detectable when the tubes were assembled.

I.——, England. W. MADDISON.

Dotting Attachment for Ruling Pen

A small block *C*, of German silver or steel, about 1/16x¼x⅜ inch, is inserted between the blades of the ruling pen, with the adjusting screw of the pen passing through the center to hold it in place.



DOTTING ATTACHMENT FOR RULING PEN

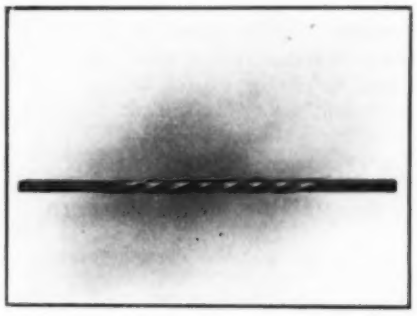
Block *C* is tapped on the side for the set-screw *B*, which holds the blade *A* through an oblong slot to allow for vertical adjustment. The blade *A* should be made of spring steel and slightly rounded at the lower end.

By inclining the pen to the right, the blade *A* will be lifted above the ridges *D* in the triangle or scale, and will make a full line until the pen is raised sufficiently for the blade to strike the ridges. The amount of inclination of the pen can be adjusted by raising or lowering the blade *A*, which is held firmly by the block *C* by the setting of screw *B*. L. L. McCOY.

Twisting Bars in a Bolt Cutter

The half-tone shows an unusual product of a bolt cutter. After sending outside for several years for all the bolt cutting required in a small shop engaged in structural iron work, an opportunity presented itself to buy a good second-hand power-driven bolt cutter, and this is a job that soon found its way to the machine, saving considerable hard hand labor and reducing the cost.

The material is wrought iron, ⅝ inch square. One end is held in the tap chuck that came with the machine, and the other end in the jaws for holding the pipe. After counting the revolutions of the spindle for the first piece, all succeeding pieces came the same by making the same number of turns. The work was done cold, and no trouble experienced in making the twist uniform. This job is a good illustration of how a machine is often called upon to do something entirely different from that for which it is intended.



BAR TWISTED ON A BELT CUTTER

G. GIBSON.

Distortion of Steel in Hardening

I am very much interested in the discussion as to the change of shape of steel and other metals in being heated and cooled, as mentioned by W. L. Hardy on page 423. I have had many years' practical experience in hardening carbon steel, as well as with metals of almost every description, and it has been my experience that all metals will shrink by heating and cooling.

As an example I may mention the case of a duplex Worthington steam pump, which I repaired as long ago as 1885, in which the pump cylinder was 10 inches in diameter. I had to replace the brass bushings, which were worn. These bushings were originally pressed into the cast-

iron sleeves in a hydraulic press and were still tight, so that I had to remove them with screws.

The chief engineer directed that the sleeves be heated and shrunk on the brass bushings, but I felt uneasy about it, and notified the manager that it would not make a good job. Unfortunately it was done as the chief engineer directed; as a result the outside of the sleeve was too small to make a driving fit in the cylinder. I informed the chief engineer, who said he had no knowledge that cast iron would shrink, but he had a good example of it in this case.

Considering the case of carbon tool steel, let us suppose we harden a slitting saw of any diameter and thickness. It will shrink perceptibly in size, and the pressure of the shrinkage on the outer edge, or periphery, will diminish the size of the hole, and it will not go on the arbor. If we except the amount of oxidization, the weight will remain the same.

The distortion will always be found on the largest diameter, and I have noticed in practice that carbon steel will shrink more than metals which do not harden. It is also a fact that by actual measurement all metals will shrink when heated and cooled. In tempering tool steel in a quicksilver bath, the shrinkage or distortion will not be as great as though tempered in oil or water. It has been my experience that carbon steel will not increase in size or expand in any way in hardening.

HERMAN FLETCHER.

A Grinder with Special Attachments for Metal-pattern Work

The grinder illustrated by Figs. 1, 2 and 3 may be of interest to others who are situated as I was. I had considerable

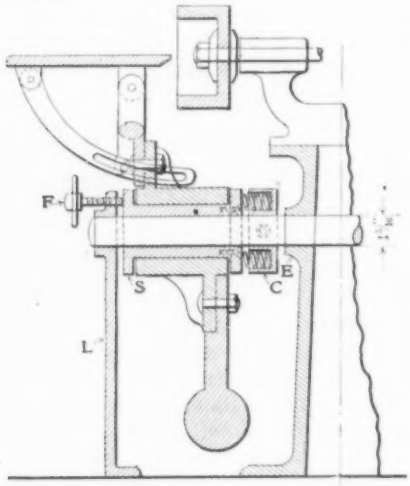


FIG. 1. SECTION OF GRINDER THROUGH THE ADJUSTABLE TABLE

grinding to do on metal patterns for molding-machine work and in fitting up metal flasks. The department did not have a grinder, therefore more or less time was lost in going back and forth to the snagging room.

The patterns for a grinder base and head were built to supply the snagging room with proper facilities for snagging castings. After enough castings from the pattern of the base had been made for that department, a boss, Fig. 1, was added to the pattern on each side and cored large enough to take a 1 15/16-inch cold-

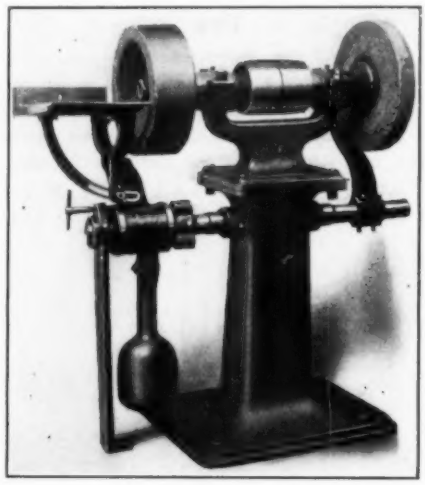


FIG. 2. THE GRINDER SHOWING THE ADJUSTABLE REST

rolled spindle running parallel with the spindle in the head. In fitting up this grinder for the metal-pattern room, an extra swinging table was added to one end, to do special grinding, while the other end was used for general purposes. On this latter end a rest was set-screwed to the lower spindle, so arranged that it can be adjusted as the wheel wears away. This end can also be used for buffing wheels, and a special frame was built to drive a polishing belt.

This frame was made to give the required distance between the centers of the pulleys for the belt, and one end was bored out and fitted to the lower spindle and set-screwed in place. The other end of the frame had a leg with a large foot, so arranged that it can be bolted to the floor. This leg also carried a long arm to which was fastened the back pulley. This arm was hinged at the center as shown in the illustration Fig. 3, and near the bottom was provided with a long adjusting screw to be used in changing the tension on the belt. This arrangement makes a very rigid polishing frame and at the same time it can be adjusted to any tension desired. The device is very useful where there are many patterns having a round or oval section. They can be finished quickly with the belt and without any filing whatever. It requires only a few minutes to set it up, and when it is not used it is of such a size that it does not take up much storage room.

The special swinging table on the opposite end is simple and inexpensive. It is adjustable to any angle up or down and has an adjustable fence which can be swung to any angle. This fence is easily removable.

Fig. 1 shows the method of adjusting the table to the grinder-wheel. This wheel is a 12-inch cup. In Fig 1, C is the back collar on the lower spindle. It is set-screwed to the spindle and has three deep pockets to receive springs. These springs force the table away from the emery wheel as the adjusting screw is loosened. They project a short distance out of the collar, say about ½ inch. The outside leg *L* has a boss projecting upward for the adjusting screw *F*. The flange sleeve *S* is a working fit on the spindle and slides as the adjusting screw is moved. The other details of the construction are so plain as to need no description. However, one other point is important, which is that as the lower spindle is located quite low in the base of the machine, about 24 inches in distance, so that it can be used for long work. Of course this swinging head or rest is hand operated, but it is needless to point out that, by its use, work can be produced much more rapidly and accurately than by filing. The half-tone Fig. 2 shows the finished rest in place, while Fig. 3 shows the belt-strapping device which is on the other end of the machine.

R. P. DOTTEN.

A Gage for Setting Gear Cutters and Work

The article on page 388, by Dynamic, recalls to my mind another, and I think, better, method for centering gear cutters. Dynamic apparently assumes that the cutters have been formed perfectly square and that the teeth all lie in the same plane, which is not always the case. If this is true, it will be seen that the gage described in the above mentioned article will only center the corners of the cutters, which is of little consequence when the sides or form are not central.

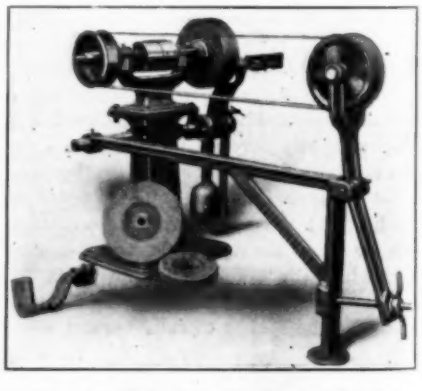


FIG. 3. THE GRINDER SHOWING THE STRAPPING ATTACHMENT

The following method is useful and sure for both milling and automatic gear-cutting machines. The cutter is first centered as nearly as possible with the center

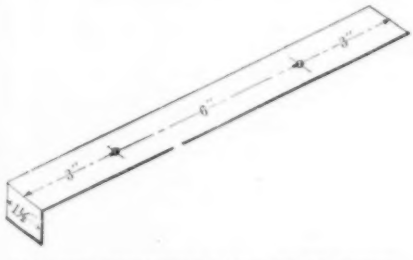
in the dividing head. A cast-iron blank is then clamped between centers and a full-depth cut taken. The sides of the cut in this blank are then coppered and it is placed on the arbor in the reverse position and left free to turn. The cutter is then approximately centered while stopped. It is then started and run through the space (the blank being free to turn will allow the cutter to bring the space in line) and will, if central with the arbor, scrape the copper from both sides of the space. If not central, it will scrape the top of one side and the bottom of the other. If it is not central, the cutter or blank is moved in the proper direction to make it so and the operation repeated.

If the first cut is quite heavy, the cutter may cut so deeply that when the blank is reversed the cutter will not scrape the sides of the space; it is then only necessary to bring the cutter and blank 0.002 or 0.003 inch nearer together to gain this result. By using this method we deal with all the teeth at once, and if the teeth do not all lie in the same plane (due to warping in the hardening), we see that this is a distinct advantage, as we do not have to test each tooth to find the most central position for the two extreme teeth.

B. F. W.

A Handy Way to Bind the American Machinist

During late years I have noticed several articles in your valued paper describing how to bind or file the AMERICAN MACHINIST cheaply. Some of these were good, although more elaborate and requiring more tools than one which I have been employing for years.



GAGE FOR PUNCHING PAPER TO BE BOUND

I use an ordinary belt punch, which can be bought for 25 cents, or even 10 cents when made of sheet metal. After the arrival of my copy of the AMERICAN MACHINIST, I take the gage shown and punch two holes through the paper, as laid out on the gage. Then I lace it to the other copies into half-yearly books, with ordinary shoe laces of the cheapest kind, costing five cents per dozen, bought at the factory entrance on some pay day.

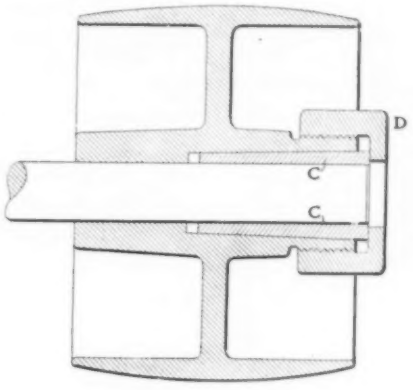
The paper gage serves as bookmark with the last article I have been reading. The whole takes only a moment's time and has an advantage similar to the loose-leaf filing system that single copies or articles can be removed and replaced without great trouble or loss of time.

I hope that others may take advantage of this little trick.

B. OSCAS.

A Sure Way of Tightening a Pulley on the Shaft

One of our electric motors used to give us some trouble owing to the fact that



SURE WAY OF TIGHTENING PULLEY ON SHAFT

the strain on the pulley tore away the side of the keyseat, until at last the side of the groove gave way entirely. The shaft being of small diameter, another keyway would have weakened it still more, and the turning of another shaft would have compelled us to dismount the machine. We avoided this by adopting the solution shown in the illustration. The hub of the pulley was tapered internally and threaded externally for a certain length. Three wedges *C* were obtained by cutting a solid piece with a hole of the diameter of the shaft and turning the outside taper to fit the taper in the pulley hub. These projected about one-fourth inch and were forced between the pulley and the shaft by the threaded collar *D*. This simple arrangement made a strong and sure grip on the shaft, which has worked well ever since.

G. SACERDOTE.

That Suggested Milling Cutter

The milling-cutter suggestion on page 457 has called forth a number of interesting criticisms, most of which are based on a misconception of the author's meaning or his failure to put in an explanatory line to the effect that the contour of the cylindrical surface was not to be disturbed. This makes it a four-tooth spiral milling cutter with half the teeth running right-handed and the other left-handed.

One milling-machine man believes that the reversing cut spoken of would be objectionable on account of one end of each doing very little work and the other much more than its share.

The question is, Has this form of cutter any advantages over those regularly in use? If not, the novelty is only of value in inciting interest in this line, which may result in improvements later on.—Ed.

The Design of Eccentric Pull and Push Rods

When an eccentric or offset rod is considered simply as a machine element and designed to clear some obstruction, the amount of offset is known. A formula with this offset as an element, rather than the lever arm or distance to the neutral axis, is somewhat easier of application and is readily developed from the usual formula for combined stresses. The numerical work may be somewhat shortened by assuming the rod to be extended into a suitable section to resist the direct tension or compression and using this equivalent section to determine the required section through the offset. The general statements leading to an equation are as follows, referring to Fig. 1:

Let P be the pull to be transmited through the rod shown, having an assumed breadth b.

S = the safe working tensile stress per square inch in the extended section and also represents the sum of the stresses in the offset section due to the direct tension and to the tension due to flexure. The direct stress through the offset is equal to $\frac{P}{D\,b}$. The stress through the offset due to flexure is equal to $\frac{P\,x}{Z}$ where Z is the modulus of the section and, in the case of the

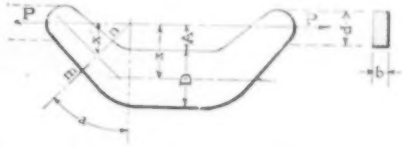


FIG. 1. DIAGRAM FOR AN ECCENTRIC ROD

rectangular section assumed, is equal to $\frac{D^2\,b}{6}$.

As the sum of these stresses must be equal to the stress through the extended section, or $\frac{P}{d\,b}$ the equation will read:

$$\frac{P}{d\,b} = \frac{P}{D\,b} + \frac{6\,P\,x}{D^2\,b}. \qquad (1)$$

Solving this equation,

$$D = \sqrt{6\,x\,d + \left(\frac{d}{2}\right)^2} + \frac{d}{2}.$$

Substituting for x its value expressed in terms of A and D, $x = \frac{D}{2} + A$, the equation will read:

$$\frac{P}{d\,b} = \frac{P}{D\,b} + \frac{6\,P\left(\frac{D}{2} + A\right)}{D^2\,b} \quad (2)$$

Solving,

$$D = \sqrt{6\,A\,d + (2\,d)^2} + 2\,d.$$

Checking a section $m\,n$ through the leg may be considered as a modification of equation (1), in which the direct pull P is resolved into a tension along the axis of the leg equal to $P\ cos.\ a$, and a shear at right angles to it equal to $P\ sin.\ a$. The equation (1) will then read:

$$\frac{P}{d\,b} = \frac{P\ cos.\ a}{D\,b} + \frac{6\,P\,x}{D^2\,b} \quad (3)$$

Solving,

$$D = \sqrt{6\,x\,d + \left(\frac{d\ cos.\ a}{2}\right)^2} + \frac{d\ cos.\ a}{2}.$$

Working out the illustration given in the article on page 292, $P = 40{,}000$ pounds, angle $a = 45$ degrees, $x = 10$ inches, $S = 20{,}000$ pounds, $b = 2$ inches; to find D at section $m\,n$:

$$\frac{P}{S} = b\,d = \frac{40{,}000}{20{,}000} = 2.$$

$$d = \frac{b\,d}{b} = \frac{2}{2} = 1 \text{ inch.}$$

$$D = \sqrt{6 \times 10 \times 1 + \left(\frac{1 \times 0.707}{2}\right)^2} + \frac{1 \times 0.707}{2}$$

$$D = \sqrt{60 + 0.1253} + 0.353.$$

$$D = 7.75 + 0.353 = 8.1 \text{ inches.}$$

J. A. Brown.

Jig and Mandrel for Machining Small Pulleys

Not having a turret or pulley lathe to bore and turn our pulleys, we rigged up to do them on the drill press and engine lathe, as shown in sketches Figs. 1 and 2.

Fig. 1 is the jig for drilling and reaming the hole in the drill press. The distance pieces A are cold-rolled shafting, faced true on the ends and tapped to receive the cap screws that hold the bushing arm to the base of the jig. We use different lengths of these for different widths of pulleys. We cast our pulleys from iron patterns with boss or hub turned true with the rim, and as the bushing fits down over the boss or hub the pulley is centered fairly well. The rim rests on the bottom of the jig, so it is sure to run true on the sides.

We run a three-fluted chucking reamer through first, and then the sizing reamer. We then key-seat them on the drill press with a national key-seating tool. The operator can do these pulleys on a press with power feed and run another one at the same time.

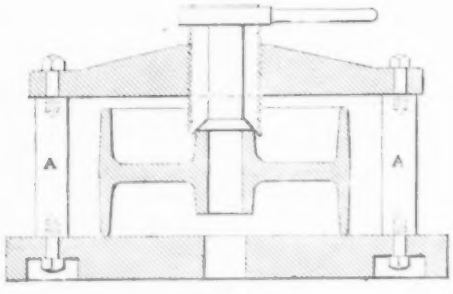


FIG. 1

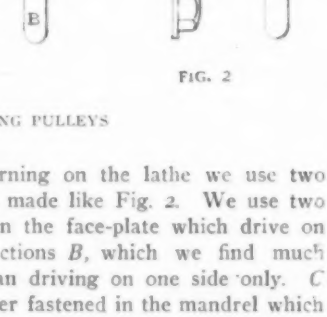


FIG. 2

JIG AND MANDREL FOR MACHINING PULLEYS

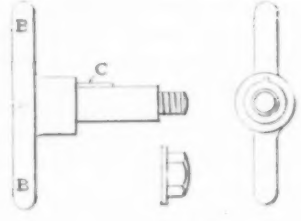


FIG. 1

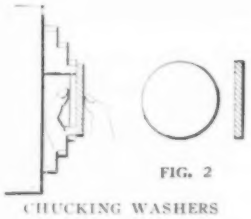


FIG. 2

CHUCKING WASHERS

For turning on the lathe we use two mandrels made like Fig. 2. We use two drivers on the face-plate which drive on the projections B, which we find much better than driving on one side only. C is a feather fastened in the mandrel which fits the keyways in the pulleys, thus obviating any tendency to slip on the mandrel. The pulleys are easily changed and by having two mandrels the operator can always have one ready to put in when the other one is ready to take out. We can take a cut all the lathe, high-speed steel or belt will stand and not chatter, and as the boring is done on an inexpensive machine and the lathe kept busy about all the time the cost is pretty well reduced.

We do not claim to beat a Gisholt turret lathe on this class of work, but we are driving it pretty close. We do pulleys 6 inches to 14x6 inches face by this method.

S. E. Reng.

Two Handy Lathe Kinks

A very quick method of chucking small collars or washers to be refaced or rebored is shown in Fig. 1. In this A is the work, B is a washer counterbored to slip over the work, as at C.

In chucking, hold the work and washer together and place in chuck, pressing washer against chuck jaws (as shown in cut) and tighten chuck.

Fig. 2 shows plain washer for use where work is to be bored only.

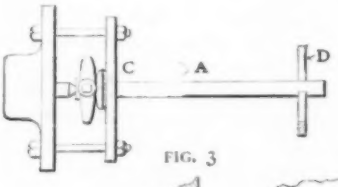


FIG. 3

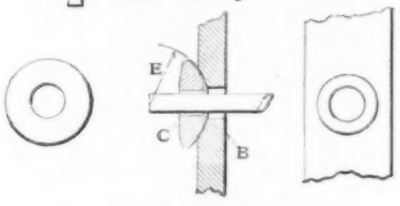


FIG. 4

STRAPPING WORK TO THE CENTER

By this method work can be handled very rapidly.

Another handy kink in lathe work is shown in Fig. 3 for strapping work to the live center while using the steady-rest D. A is the work, B is the strap, C is a steel button bored to slip over the work, its face turned convex to a radius equal to its own thickness plus the space occupied by the driving dog, as at E Fig. 4.

The strap B is drilled somewhat larger than the work and concaved to fit the button, making a ball joint, which allows for the unequal pull of the bolts and consequently prevents springing the work.

H. J. Chinneck.

A Pump Experience in the West

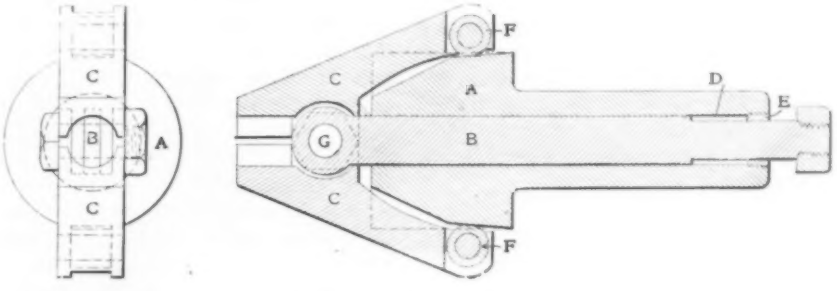
On page 97, F. A. Taylor asks for further details of the pump concerning which I wrote some months ago. This pump was a direct single-acting steam pump with outside packed plungers, steam cylinder 30 inches in diameter, water cylinder 10 inches in diameter, 20-inch stroke, suction pipe 10 inches in diameter, and discharge pipe 8 inches. There was a large air chamber on the discharge side but none on the suction. A good foot valve was on the bottom of the suction pipe, but the swing check, on the discharge pipe close up to the pump, is what I con-

sider the bad feature of the installation, as it neutralizes the action of the air chamber.

I ran this pump with a pressure gage on the discharge pipe outside of the check, and found the pressure rose to over 500 pounds at each end of the stroke while working under a head of 570 feet, but on changing the gage to a position between the pump and the check, the pressure indicated was never greater than 250 pounds at any part of the stroke. The owners of the mine claimed that the check had nothing to do with the hammer, and that it was all in the pump. However, I still think that I am right, and it will take some strong talk to cause me to withdraw from my position. It would certainly have been better to have had a vacuum chamber on the suction, although there was only 15 or 20 feet of suction pipe; but I claim that the swing check must come out before the pump would work satisfactorily. Am I right, or am I wrong? SENEX OCCIDENTALIS.

A Semi-automatic Chuck

For certain reasons it was desirable to hold some cold-rolled rods in the turret of a screw machine and transpose the box tool to the collet in order to machine the ends of the pieces. There were two sizes of rods, 0.750 inch and 0.875 inch in diameter. They were automatically gripped by this chuck—see the illustration—just as the pressure was brought to bear on the work. There are two chucks to accommodate the two sizes.



A SEMI-AUTOMATIC CHUCK

Referring to the sectional illustration, it will be seen that *A* is the shank which is bored to receive the retaining member *B*. The function of *B* is to centralize the jaws *C C*, and its travel out or in is limited to the opening and closing of the jaws. In the opening at *D* is a coiled spring whose thrust against the nut *E* and the shoulder of *B* always has a tendency to keep the jaws open. On opposite sides of the shank *A* are milled beveled slots. On these bevels ride the rollers *F F*. The angle is so slight that the jaws which are hinged together on the member *B* at *G* hold the rod very tightly. CARROL ASHLEY.

Drawing a Circular Arc Tangent to a Given Arc and to a Given Straight Line, at a Given Point

The interesting problem of Brachistochrone, at page 307, recalls to mind a problem which arose some time ago, the solution of which was an actual necessity for the correct construction of a machine part, namely, to draw a circle tangent to a given circle with center at *O* and to a given line *L* at a given point *P*. This is a general problem of which your correspondent's is a special case, where the line passes through the center of the circle, or is a diameter produced.

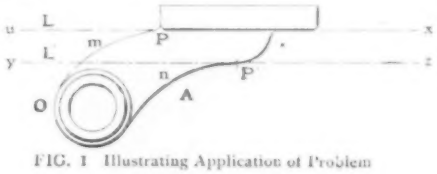


FIG. 1 Illustrating Application of Problem

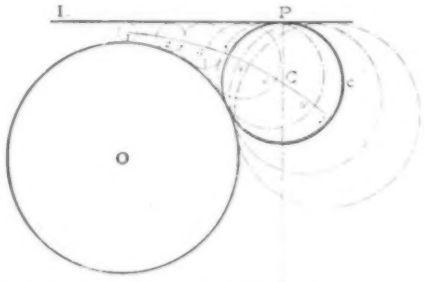


FIG. 2 Method of Solution by Drawing a Locus of Centers of Tangent Circles.

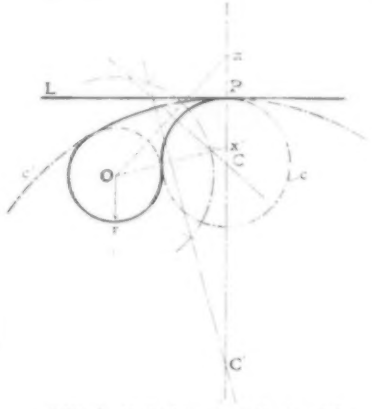


FIG. 3 Method by which Center of the Tangent Circle is at once Obtained

TO DRAW A CIRCLE TANGENT TO A GIVEN CIRCLE O, AND TO A GIVEN LINE L, AT A GIVEN POINT P

It is obvious that there are always two such circles possible. When the line passes through the given circle, they are on opposite sides of the line; when the line passes through the center, they are equal. In the other case, where the line does not intersect the circle, the two circles that fill the conditions are the one to which the given circle is tangent internally and the one to which it is tangent externally. These may be called the including and excluding tangents. The limiting case is that in which the circle itself is tangent to the line at the point, when the excluding tangent becomes a point and coincides with *P*, and the including coincides with the given circle, when considered as tangent to it at the side opposite the point. In reality the number of such including tangents is then infinite, they being tangent to both the line and the circle at the point *P*. When the given circle is tangent to the given line at any other point than *P*, the including circle becomes of infinite radius and coincides with the given straight line.

ONE APPLICATION OF THE PROBLEM

As an example of the use of such circles (or arcs), the bracket *A*, Fig. 1, is shown. This is of admittedly poor design, but serves as a suggestion of what may be required. Here arc *m* is of the including circle; arc *n* of the excluding.

SOLUTION BY THE LOCUS METHOD

The first solution found was by the graphic or curve method, as shown in Fig. 2. It is evident that an infinite number of circles can be drawn tangent to the circle and to the line. A sufficient number of these were drawn, and their centers, 1-7, found to lie on a smooth curve, to be exact, a parabola. The point *C* where this curve intersected the perpendicular from the given point *P* was the center of the circle sought. In fact, it is not necessary to draw the circles, but merely to find their centers, as follows: Draw on the side toward the circle a parallel to the given line at any distance from it, and with a radius equal to the sum of the radius of the given circle and this distance, strike an arc, from the center of the circle *O*, intersecting the parallel; the point of intersection is one of the centers. Here only the excluding tangent is considered; the including tangent would be found in similar manner, but subtracting

the radius from the distance between line and parallel.*

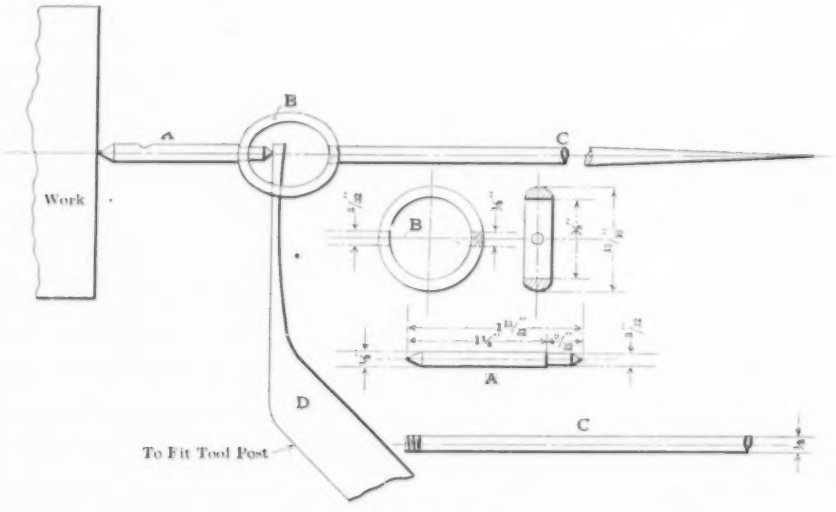
A Method Which Gives the Solution at Once

But this solution was so unsatisfactory that the one shown in Fig. 3 was developed, which is similar to that of your correspondent, except that it takes the case of the non-secant line and covers both the resultant possibilities. Taking X and X' on opposite sides of the given line, at a distance from P equal to radius Or of the given circle and on the perpendicular from P, connect them with O and bisect, extending perpendicular bisectors to intersect the perpendicular at C and C', the centers respectively of the excluding and including tangents. For $Cx = CO$ and $CP = CO - Or$, also, $C'x' = C'O$ and $C'P = C'O + Or$.

H. V. Purman.

A Test Indicator

The sketch illustrates a simple center indicator constructed by a machinist of my acquaintance. It consists of piece A which is stubs' steel, hardened and made a tight fit in steel ring B, and piece C which is threaded on one end to fit B. A and B are dimensioned clearly in the sketch. Pointer C can be made any length desired, the one shown being 12 inches long. The sketch shows the tool



TEST INDICATOR

in use, the large end of A being held in position by shank D which has a flexible end hardened, spring tempered, and centered to receive the small end of A. One side of ring B rests on D to keep it from turning.

C. W. R.

*In the case of the including tangent there is of course a minimum limit to the distance at which the parallel may be drawn from the given line; since, if it be drawn too close, a center could not be found by the intersection method described.—Ed.

A Tool Chest That Is All Drawers

The number of drawers can vary as you wish, but all should be fastened with an automatic lock at back. By opening cover, a spring releases the bar at back of drawers, and by shutting the cover the bar at the back is forced down through a notch A which is screwed to the bottom of each draw at the back and secures all the draws.

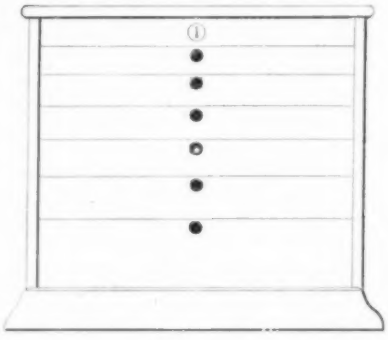


FIG 1

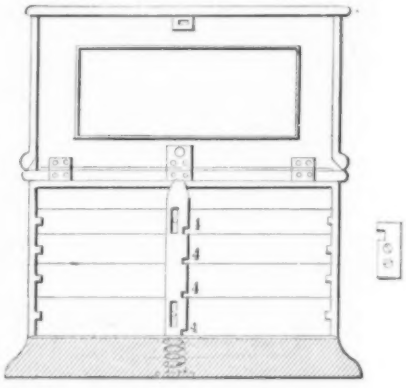


FIG. 2

A HANDY TOOL CHEST

The bar is screwed to the back of body of tool chest. A piece of steel ⅛ inch thick, ¾ inch wide, and 1½ inches long with two screws ½ inch long, and a square notch cut in edge for the bar to pass through as at A. Fig. 2 shows drawers all out, looking at the back with cover up. Fig. 1 shows the chest all closed and locked, with 6 draws, space underneath and space in top when cover is open, and a lock to the cover also. The lock should be a spring lock to save time.

The bottom drawer is the deepest for larger and heavier tools. The drawers slide on gibs shown in Fig. 2. The top is paneled for looking glass or for scales or small tools. The middle hinge drives down the bar against spring at bottom of bar. It has only to go down about ⅛ or ¼ inch to lock all the drawers. Under the bottom draw is space for drawings or tools you don't care to lend.

Gilbert Parker.

Does It Pay to Write?

Yes, it does and in more than money, though I confess that, when I got my first check for $2 for an old photograph that I happened to pick up and about which I wrote a description in fifteen minutes, it seemed to me the money was "easy," to say the least. I began to think of how long it had taken me to design and build the thing of which I had written, and even of what it cost me to take the photograph. I concluded that this additional $2 was only a little extra pay that really belonged to me, and could be mine in many other cases if I wanted to reach out and grasp it.

To be sure, if you are designing for a firm it is hardly fair to publish your designs without their permission; yet even if that is withheld, it is often possible to describe details or discuss principles without giving away secrets. This very summer I have been designing some machines for a client who is so anxious to keep them secret that he is having the parts made in several different shops and assembling them himself. But without giving away any part of his secrets I have been able to earn 50 per cent. of his fee by writing descriptions and discussions of parts of the machine. To many firms the advantages of publicity in news columns in addition to straight advertising are growing apparent. If you are right on the ground, you can convince your firm that you are the proper man to take care of their write-ups. Doing such work necessarily makes you think about the things which come under your observation, makes you more familiar with the business and, more than that, you immediately find that you did not know so much as you thought you did. The best way to find out whether you know about a thing or not is to try to teach it to someone else. The

next best way is to write a description of it that gets past an editor. That is the greatest advantage—its educational value to yourself; not only as to cleanness in writing but in knowledge of what you write about.

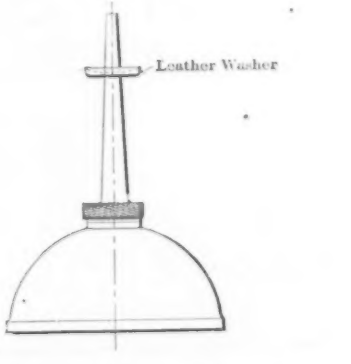
I started out about three years ago to write about skew bevel gears. I had just had a pair cut that ran nicely. The man that cut them had told me that he did not know anything about such work, so I laid them out for him and told him just how to do it. I wrote my article. Then I thought I would try it myself to see that I had not left out anything. I could not cut them at all. I still have the article and my mutilated gear blank, but I don't know a thing about skew bevel gears.

If you are situated as I am, where you feel that some of your aunts and uncles think that writing for the technical press is the first step toward becoming a poet, then use a pen name. If you cannot stir up a discussion in any other way, pick up another pen name and write on both sides of a question. But even if you do use a pen name, people will find you out, as one did a little while ago who wrote to me as follows:

"Dear Sir—I have been informed that you have achieved some success in a literary line; and as I am in search of poems that can be set to music, I take the liberty of addressing you, etc, etc." Now what do you think of that? Don't tell me that there is nothing in writing but the money. ENTROPY.

Drip Preventer for an Oil Can

The accompanying sketch shows a little "kink" with regard to oil cans, and needs little explanation. The idea of the



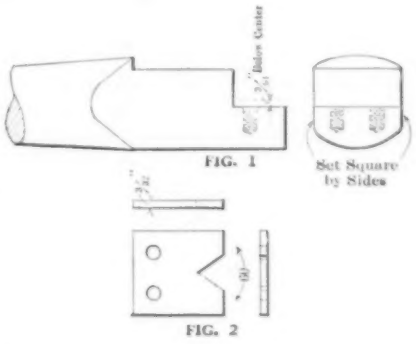
DRIP PREVENTOR ON AN OIL CAN

leather washer is to keep any oil from running down the outside of the spout onto the bench, or wherever the can happens to be. I don't claim this to be an original idea, but think there may be some of your readers who have not seen it

W. CONRAD

A Gage for Setting Gear Cutters and Work

On page 388 is an article by "Dynamic," on gages for setting gear cutters central with the work. The accompanying sketches show a centering tool for setting gear cutters on the milling machine,



A GAGE FOR SETTING GEAR CUTTERS AND WORK

which I have used for a number of years with satisfaction.

This tool or gage is made in two parts. Fig. 1 is a taper shank of tool steel, hardened and ground all over, which fits the taper hole in the dividing head. This is first milled with the flats on the end while it is in the dividing head; afterward it is hardened and ground. The flats are used to square up by. Fig. 2 is the gage, which is screwed to the center flat.

It is made from tool steel and is hardened and ground. It projects over the end of the shank so that the edges of the 60-degree V can be brought in contact with the cutter and thus centralize it with the work arbor and the work.

EDW. J. RANTSCH.

The Wearing of Rawhide Pinions

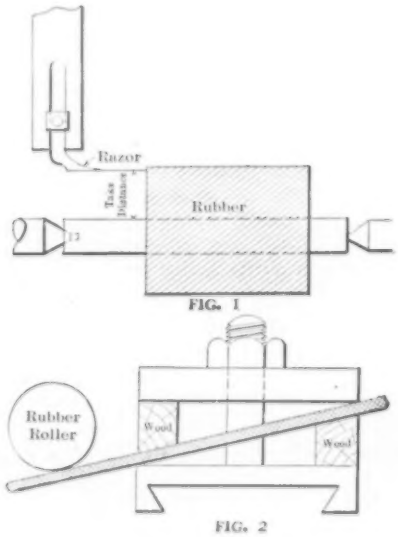
On page 817 of Vol. 30, Part 1, A Greaser says that he is using intermediate rawhide gears which are not entirely satisfactory. I would like to say that I have found rawhide gears or pinions, when rightly designed and properly cared for, to be noiseless, and that they have fully as long a life as iron gears in the same place. After three years of constant use the wear is no more, if quite as much. About four years ago I designed some rawhide gears and pinions to have a peripheral speed of about 5000 feet, or nearly a mile, per minute. As this was thought by the office to be a radical departure, I watched them very closely, examining them at least twice every week for about two years. At the end of that time they were in thoroughly first-class condition. For three years I know that nothing was needed in the way of repairs to them or to the machines on their account. These machines were hardly idle more than a half an hour a day, and were started and stopped probably some 40 to 50 times during the day. Sometimes they ran for only a few minutes before being stopped, to be immediately started again by someone else, and often running for four or five hours steadily. I have also tried them on very heavy duty, where they stood up better than steel or gun metal, and with fully as good results; but proper allowance must be made for the strength of the material. C. W. GRANT.

Turning Rubber

I have seen lately one or two articles on turning and truing rubber, but for turning I have not seen a good one. The following I suggest as the most suitable that I know.

Get an old razor, bend the handle end square with the blade, mount it in a holder as at Fig. 1 and you have one of the finest turning tools for rubber you could wish for, and I can safely say from experience the quickest. When using this tool, care should be taken to bring the blade about 1/64 inch below center. To set up the tools for cutting, measure from the mandrel or the spindle that the rubber is being turned on. If an extra good finish is required, touch with very smooth glass paper, finally using a little French chalk.

Fig. 2 shows my way of truing a rubber roller when there is not sufficient



TURNING RUBBER

stock for a cut. Get a sharp file, bolting it in the tool rest, as shown, or in fact, any way you can. Anyone having any dimculty with turning rubber will soon get over his difficulties by adopting these methods. C. HOLT.

England.

Points about Lathes and Shapers

Here are a few criticisms and suggestions regarding lathes and planers. In the years I have been at work, I have never found all the good features on any one machine, but some on one machine and some on another. The changes mentioned are only the little devices that are inexpensive, but very much appreciated by the machinist.

About Lathes

First, why a double handle on cross-feed screw, so that when turning it you will bark your knuckles on the center nut, while the hand wheel on the tailstock goes without any? Second, protected oil holes in carriage and tailstock, so as to get the oil on the ways, are better than to daub the ways with oil for the carriage to rub off when sliding back and forth. Third, why not graduate the compound screw as well as the cross-feed screw? Fourth, carriage-locking device in front, instead of at back, so as to be within reach of operator. Fifth, clamping nuts of tailstock so situated that a wrench may be turned at least a half turn. Sixth, apron so arranged on all lathes that the pinion can be thrown out of mesh during screw cutting. Seventh, hand wheel instead of balanced handle for longitudinal motion. Eighth, taper attachment adjusted with screws and graduated on one end in degrees and on other end in fractions of an inch. Ninth, slots in large face plate of an even number clear through, not T slots. Tenth, small face plate so that it will drive the ordinary dog without having to lengthen out its tail. Eleventh, back gears spaced even.

About Shapers

First, a way of stopping ram instantly in any position of the stroke. Second, a crank handle at either end of the longitudinal screw. Third, large balanced crank handle on head. Fourth, graduations on vertical screw. Fifth, protected oil holes in table, to oil cross rail, also an accessible oil hole so that the knuckle may be oiled on crank shapers.

A. D. Knauel.

Chemical Analysis Does Not Tell the Whole Story

Does chemical analysis tell the whole story? There is no doubt about it in my mind that it does not, and my experience is based on the chemical compounding of a commodity that was a known and tried product, although far removed from steel. The same faults were apparent as in the cases cited by your editorial, which I believe was to the point.

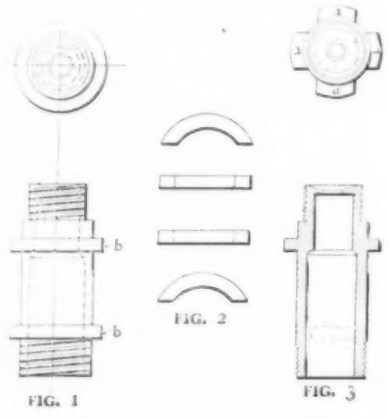
The formula of this product was lost, and the analysis made by the chemist, although producing apparently the same article, was so costly as to be prohibitive. Becoming interested in the case I studied and experimented, and finally found a practical process for making it. The chemist did not know what the trouble was; although everything has been done exactly as he desired, the results were entirely unsatisfactory.

The compounding of a formula is the most powerful protection that any formula can have, as, while the analytical chemist can give a quantitative and qualitative analysis, he cannot tell how it was put together, although he may occasionally hit it right. In order to tell positively just how a compound is produced, it is necessary to see it done.

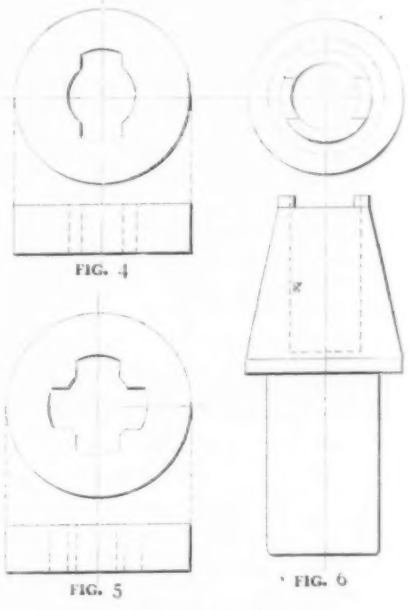
August H. Nolting.

Press Tools which Superseded Milling Tools

The press tools illustrated herewith show evolution in manufacturing operations. The piece to be made is shown as a blank by Fig. 1 and finished by Fig. 3. The blanks were lathe made.



BLANK AND FINISHED PIECE



FINISHING DIES AND PUNCH

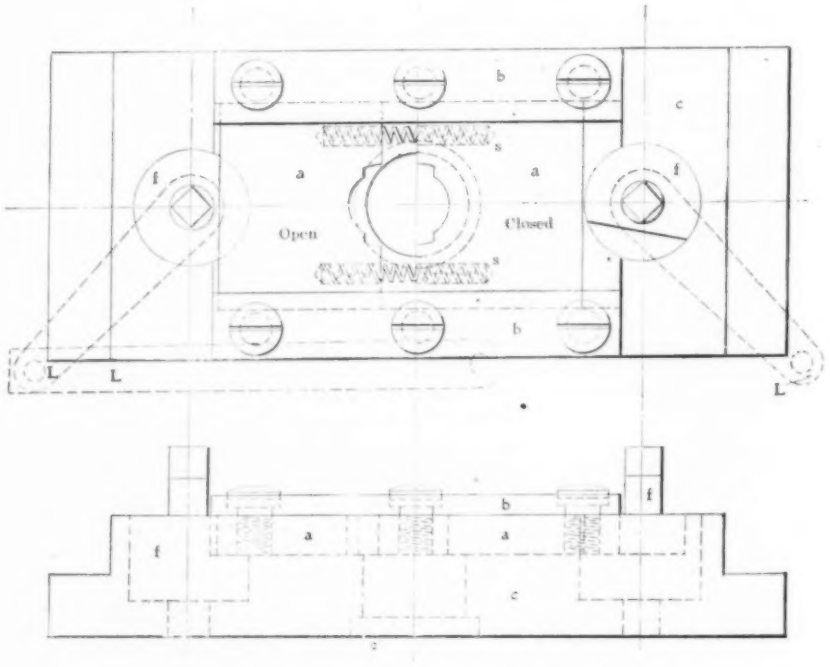


FIG. 7. THE DIE WHICH SUPERSEDED THE OTHER TOOLS

The original method of finishing the projections *a* was to rough mill them with a formed cutter and then shape them with the die, Fig. 4, and obtain the correct alinement of the two pairs of lugs by the die, Fig. 5. This method gave good re-

sults, but was too slow to meet the demands of production. We therefore made the die, Fig. 7, to do away with the milling. It was successful, produced good work and at a much reduced cost. At that we only had a small hand-power screw press to use on the job.

The die, Fig. 7, is made in two pieces *a a*, which slide in the cast-iron block *e*. They are opened by the two coiled springs *s s* and are closed by the cams *f f*, which are operated by the levers *L*. The engraving shows one-half of the die open and the other half closed. The punching is done in two operations and the opening feature allows one of the flanges *b*, of Fig. 1, to pass through the die when the other flange is to be shaped.

Fig. 6 shows the punch. It is made hollow at *g* to take the pieces, Figs. 8 and 9,

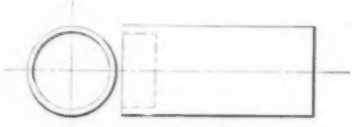


FIG. 8

FIG. 9

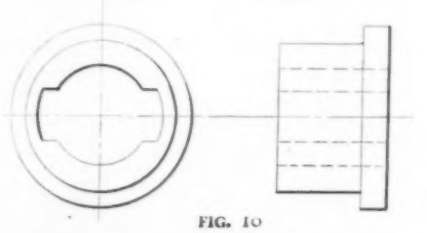


FIG. 10

REMOVABLE PUNCHES AND THE GUIDE BUSHING

so that both ends of the piece can be operated on without changing the punch. The piece, Fig. 8, is for the upper end of the blank, and the one in Fig. 9 for the lower end. After the first operation, the guide, Fig. 10, is put in the base block of the die *c* at the point *e* and brings the lugs which have been shaped into the proper relation with the die above. The pieces punched from the flanges are shown by Fig. 2.

Several hundred pieces have been made with these tools with success. The saving over the milling method is considerable and the milling machine is free for other work. JOHN J. SEIBERT.

Government Specifications and Inspection

The editorial published on page 348, entitled "Government Specifications and Inspection," may not have appealed as strongly to the majority of the readers of AMERICAN MACHINIST as to those of us who are engaged in the manufacture of material which undergoes Government inspection, and have time and time again had, and are still having, just such—and oftentimes worse—experiences with the persons appointed to inspect our work. The topic is a most interesting and important one; if those of us who are engaged in such work dared to write up a few of our experiences with Government inspectors, I think it would bring out such a large number of instances of ridiculous decisions in just such cases as the one described in your editorial as would open the eyes of any manufacturers contemplating entering the field of Government contract work. It would show them what they can expect to encounter after being fortunate(?) enough to secure a desired contract, and would doubtlessly result in still higher prices being paid by Uncle Sam for his material than is the case at the present time.

Having worked for a number of years in positions that brought me daily into direct contact with inspectors of army ordnance, and being for the past couple of years in charge of the manufacturing of a large variety of Government work being made under contract, I can speak on the subject of Government inspection from personal experience, and will state that it is—in my opinion—a problem into which the "personal equation" of the inspecting officer in charge of the work enters with fully as much force as drawings and specifications.

I have assisted inspecting officers of widely varying rank and age, and have almost invariably found that the more experience and natural ability the officer happened to be blessed with, with just so much less friction and delay did the work progress to completion. This was due to the fact that so many of the questions on minor details and harmless discrepancies, such as are found in all classes of machine work, were passed upon by him at once. Another officer of less experience or decision would keep a continuous string of letters going to headquarters, with the result that trivial questions would be allowed to hold up work for several weeks until a decision could be obtained accepting the pieces so far as the discrepancy would be concerned and work could once more be resumed.

Each hold-up on any piece of work in the manner above mentioned would mean that the contractor must hustle so much the faster in order to get the work completed inside the contract time, in order to avoid having to pay penalties for delay in delivering the material, because no extension of time is allowed for any delay that may arise from time lost by work being referred to headquarters by the inspector.

With an officer of sufficient inexperience or indecision, and a large enough variety of work to be inspected, it is not at all difficult for him to appear as if his chief desire is actually to prevent progress on the work as much as possible, whereas it may be that the man is quite innocent of any such intention.

Some inspecting officers whom I have known gave positive instructions to their assistants to throw out all work not exactly to drawing dimensions and tolerances, while other officers have instructed that any material not exactly correct to the dimensions required by the drawings must be laid aside for them to look over, and accept or reject the material according as they did or did not consider it satisfactory for the purpose for which it was designed.

The tendency to hold the contractor down to the very letter of the specifications is growing rapidly with Government inspectors in general, but more especially with those of the army ordnance department. It is practically useless to enter any objection either to the inspector regarding the decisions of his assistant, or to the headquarters regarding the decisions of the inspector. The line of reasoning in each case seems to be that the more a contractor kicks against the man appointed to inspect his work, the more thoroughly must the man be doing his duty. The possibility of their representative imposing an unnecessarily rigid line of inspection on the contractor is apparently out of the question.

If I were free to do so, I could cite instances by the dozen of just such unreasoning inspection as the example given in your editorial, but being engaged—as above stated—in the manufacture of Goverment material and therefore compelled to submit to the class of inspection mentioned, it would be very unwise for me to bring upon our firm any aggravated condition of a class of inspection which is already so unnecessarily harsh and exacting. So that, much as I dislike writing under an assumed name, I feel compelled to sign myself. DISCRETION.

Another inventor, R. D. Vercler, of California, has a machine weighing only a ton, with a 24-horse-power air-cooled engine, which makes up for its lack of adhesive weight by winding on a cable, the process resembling a method which has been used for propelling canal-boats. The blocks holding the ends of the cable run on other cables, so that the former automatically shifts its position as the machine travels. This machine can plow, furrow and seed (simultaneously) 24 acres in 10 hours. The day appears to be coming when the hard work of plowing will be changed to a pleasant automobile ride for the farmer.

The Pennsylvania Railroad Company now has in progress a series of experiments with electric locomotives the object being to arrive at a decision as to the best type adapted for drawing the heavy passenger trains through the New York tunnels.

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The New British Patent Act

We are in receipt of the text of the new British patent act, which contains some provisions which will be of interest to many of our readers.

The most noteworthy feature of the new law is the fact that in it Great Britain abandons the old practice of throwing upon the inventor the responsibility of determining the novelty of his invention, by which the patent was issued in any event, but with its validity subject to the action of the courts. Leading up to the abandonment of this practice we find the provision that when it appears that an invention is wholly or in part claimed in any published prior specification the applicant shall be afforded facilities for amending his specifications and, in the event of his failure to do so, the controller may insert such references to prior specifications as he considers ought to be made by way of notice to the public. Our understanding is that, by the former practice, this insertion of references was the only act which the controller was authorized to take—the patent being issued in any event, but with these references to prior inventions. To the present act there has, however, been added the provision that "The controller, if satisfied that the invention claimed has been wholly and specifically claimed in any specification to which investigation has extended, may, in lieu of requiring references to be made in the applicant's specification as aforesaid, refuse to grant a patent."

The present act also adopts a procedure similar to that now in force in many foreign countries, relative to the enforced manufacture of the patented article within the borders of the country granting the patent, the provision being, "At any time not less than four years after the date of a patent, and not less than one year after the passing of this act, any person may apply to the controller for the revocation of the patent on the ground that the patented article or process is manufactured or carried on exclusively or mainly outside the United Kingdom," and if the controller finds the contention to be true, he may either issue an order revoking the patent forthwith, or after such reasonable interval as may be specified in the order. If, however, following such an order, the article or process is not manufactured or carried on within the United Kingdom, the controller may extend the period by another twelve months in case satisfactory reasons for the delay are given.

The new act provides also for the extension of patents in certain cases, the petition for such extension being presented to the Supreme Court, the provision for the extension being as follows:

"If it appears to the court that the patentee has been inadequately remunerated by his patent, the court may, by order, extend the term of the patent for a further term not exceeding seven, or, in exceptional cases, fourteen years, or may order the grant of a new patent for such term as may be specified in the order and containing any restriction, conditions and provisions the court may think fit."

American Railway Statistics

The Interstate Commerce Commission has published an abstract of statistics for the year ending June 30, 1906, from which we select a few figures of general interest.

The total single-track railway mileage of the United States on the date mentioned was 224,363 miles, an increase of 6262 miles during the year then just finished. The number of locomotives in service was 51,672, an increase of 3315. The total number of cars of all classes was 1,958,912, of which 42,262 were passenger, 1,827,914 freight, and 78,736 company's service cars. Out of a total of 2,010,584 locomotives and cars, 1,827,789 were fitted with train brakes and 1,989,796 with automatic couplers, the increase in the number fitted with train brakes being 186,394, and with automatic couplers, 118,206. In the passenger service, train brakes and automatic couplers were almost universal, but 1.54 per cent. of passenger cars being without automatic couplers.

The total number of employees on the pay-roll was 1,521,375, who received in wages a total of over $900,000,000, this amount being, however, deficient by more than $27,000,000 because of the loss of railway records in the San Francisco earthquake and fire.

The gross earnings for the year amounted to over $2,325,000,000; but of the total capitalization 33 per cent. received no dividends, while the average dividend on the remaining stock was 6.03 per cent. The total number of passengers carried was over 779,000,000, an increase of over 60,000,000 during the year. The total number of tons of freight carried was over 1,631,000,000, an increase of 203,000,000 tons. The average revenue per passenger per mile was 2.002 cents, and the average revenue per ton mile of freight was 0.748 cent, the average passenger revenue representing a slight increase and the average freight revenue a slight decrease.

Ten thousand, six hundred eighteen persons were killed and 97,706 injured during the year, the number of passengers killed being 359 and the number injured 10,764, a decrease in the case of passengers killed of 176 and an increase in the number of injured of 207.

The figures for casualties during the year wear a better look, although one that is still bad enough, when the figures for those trespassing upon the railroad property are included. About one-half, or

to speak exactly, 5381, of the fatalities were among trespassers.

Reducing the figures to the forms usually used for comparative purposes, the results show that one passenger was killed for every 2,227,000 carried, against one for each 1,375,000 for the previous year; while for the year under review 70,126,000 passenger miles were accomplished for each passenger killed, against 44,320,000 for the preceding year. Going back to 1895, one passenger was killed for every 2,984,000 carried, while 71,696,000 passenger miles were accomplished for each passenger killed.

The Cultivation of Forests as an Industry

The movement toward forest cultivation which is beginning to receive so much attention, lends interest to any information on that subject which comes from Europe, where systematic forestry has long been practiced. In Germany forestry is largely a Government enterprise, and we learn by a report by Consul Teichman, of Eibenstock, that the industry is handsomely profitable. About 50,000 square miles of German soil, representing about one-fourth of Germany, have been adapted to foresting; while in Saxony alone over 443,000 acres are covered by Government forests—the Government and private forests of Saxony together aggregating almost one-half of the kingdom. The treasury of Saxony places the Government forests as its highest revenue producer after the state railways—the revenue from the forests, with this exception, exceeding the income from all other sources, taxation included.

Along with this, in Saxony, the cultivation of forests has been followed by a remarkable development of industries, using wood as a raw material. The leading tree cultivated is the red pitch pine, which has been found to be the most profitable wood for cultivation under the climatic conditions of Saxony. About 4000 manufacturing interests, employing 60,000 people, have been created in connection with the Saxon forests.

The climatic influences of forests have been extensively investigated in Germany, and, contrary to the general impression, they have been found to be small. The only fact established by these investigations has been that the temperature of the atmosphere under the trees in summer averages from 1 degree to 3 degrees Centigrade (2 degrees to 6 degrees Fahrenheit) less than in the air outside of the woods. During winter time it is the same for both, and the mean for the entire year shows only 0.7 degree to 0.8 degree Centigrade less for forest temperature than outside. The temperature of the forest soil was found to be from 1 degree to 3 degrees Centigrade lower during the entire year. The evaporation of free water surface in the woods was calculated to be 50 to 60 per cent. less than on non-forested soil. These are the only substantial facts thus far ascertained by these scientific researches so far as climatic effects are concerned.

The hygienic value of forests is unquestioned in Germany, their richness in ozone and dust-free character being highly beneficial to health; hence their cultivation in the neighborhood of cities.

New Publications

DIE GRUNDZUEGE DES UNTERRICHTS- UND ERZIEHUNGSWESENS IN DEN VEREINIGTEN STAATEN VON NORDAMERIKA. Eine pädagogisch-didaktische Studie, by Prof. Heinrich Leobner, Inspektor für das gewerbliche Bildungswesen im k. k. Ministerium für Kultus und Unterricht, Dept. XVI. 200 6½x9½-inch pages; no illustrations. Franz Deuticke, Vienna and Leipzig. Price, 5 marks.

Professor Leobner, upon the occasion of visiting the exposition at St. Louis, in 1904, made a tour of observation and, judging from this report, apparently covered the field from the Mississippi to the Atlantic pretty thoroughly, visiting several industrial establishments, as well as schools, colleges and other institutions. We notice, by the way, in the long list of places visited, which he, with German thoroughness, has given, the names of "Columbia (D. C.)," and the "City of New York on the Hudson, with Brooklyn and Hoboken, Ellis Island and Coney Island." Among the innumerable phases of the educational question considered, technical and industrial education come in for a fair share. Many of our technical schools are mentioned and brief descriptions of some are given; and, of a few, tables are presented setting forth the subjects and numbers of hours per week during the different years in certain technical courses.

ENGINEERING WORK SHOP PRACTICE, by Charles G. Dolan. 254 5x7-inch pages, with 152 illustrations. Methuen & Co., London. Price, $1.50.

While intended more especially for engineering students, this book will be found to be well adapted to the wants of apprentices and young mechanics, although they will find here and there passages which they cannot read. It is far ahead of most of the manuals prepared for beginners in the machine shop. The chapter on measuring and gaging, for example, will be found to contain exactly what a beginner needs to know, but finds it hard to find. The reading of micrometers and verniers is explained very fully and completely, and the subject of limit gages is clearly discussed. The old and yet ever new subject of tool steel and its treatment is handled in a thoroughly modern way, which cannot fail to be instructive. Lathe and lathe work are well handled, the principles of action of cutting tools being clearly shown. In the chapter on milling we find not only a discussion of milling cutters, but instructions for setting up milling machines, and similarly under screw cutting we find the ever recurring subject of setting up a lathe for the cutting of screws of various pitches thoroughly explained by means of diagrams of simple and compound trains of gears. The cutting of gears including spur, bevel, worm and spiral is described in the same comprehensive way.

It will be seen that the book is not limited to the simple manual operations of the shop, but that it concerns itself rather with its intellectual side and with the doing of things in which a man must use his head, in order to get ready to use his hands.

GUIDE DU MONTEUR (Guide for the Erector). 283 6¼x9⅜-inch pages, with many illustrations. Librairie Polytechnique, Ch. Béranger, Editeur, Paris et Liège.

This work is a good companion to the "Guide de l' Adjusteur," by the same author, which we reviewed at page 896, Vol. 28 (1905), Part 2, though it is a pity that there is so much difference between the two books in the size of page. Six pages of the first chapter are devoted to the hydrostatic level; the five gentlemen so assiduously observing these instruments in the pictures are certainly not good models for the beginner, their positions involving extreme parallax—but this is, perhaps, captious criticism. The presentation in Chapter II of a brief review of some elementary geometrical principles is a wise provision. Next much space is given to joints, mostly for pipes, though pipe fitting is usually nearly the last thing in the installation of machinery. Then we come to the assembly of machine parts, examples being taken from a steam engine as affording a widely representative case. The fitting and babbitting of bearings, keying on of cranks, lining up of cylinders and guides, etc., comprise the most of this chapter. The novice will be glad to have at hand the long chapter on finding and remedying troubles, such as heating and pounding. The chapter on valve setting takes up merely the ordinary slide-valve gear, non-reversing and reversing. The installation of shafting is treated quite fully, together with pulleys, belts, methods of lacing and fastening, etc.; though there is very little in the book in the way of formulas for the designer, an exception is found here in the giving of methods of computing sizes of belts. The lining up of shafting, and angular belt installations are explained and illustrated by very clear cuts.

New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

An Electric Traveling Crane with some Novel Features

The designs of electric crane trolleys as usually made by different makers have a good deal in common, and one which differs so much as does that illustrated herewith is at once noticeable. The first look at the outside of this machine (Fig. 1) discloses a smooth-looking cased-up affair with no moving parts visible, except at the opening through which the cables emerge, and the four carrying wheels. The designer's aim was to provide compactness and protection of the working parts, combined with accessibility, efficiency and ease of lubrication.

The general design has been much influenced by the last-named point; the hoist gearing, mechanical brake, electric brake, cable drum bearings, and hoisting motor bearings draw their oil supply from two reservoirs, so that oil supplied at two points only lubricates this large group of parts. In addition to these two reservoirs there is one for the outboard bearing of the motor, and one for each of the four trolley wheel bearings. The trolley gearing is lubricated by being partly submerged in oil, and since there is no projection outside of the case the latter may be made perfectly tight against leakage, evaporation or contamination of the oil by grit or dust. The trolley and truck axles, bridge shaft bearings and such of the motor and shaft bearings as are not otherwise supplied, are oiled by rings running into oil reservoirs beneath them. The correct level for the oil in each reservoir is indicated by filling to the top of the filling pipe, one of which may be plainly seen in Fig. 4, and which, of course, is ordinarily kept closed by a cap.

The general form of the trolley may be seen in Fig. 1; the main frame, in addition to forming a foundation for the working parts, serves as a complete inclosure for them. At each side are the two principal castings, one of which incloses the gearing and has the magnetic brake bolted outside of it; the other has bolted to it the motor. Between these two castings is a middle one which is open on the lower side and which covers over the hoisting drum, and which is of a length suited to the hight of hoist and corresponding length of drum. To the main castings are bolted the axle brackets which carry the bearings for the trolley wheels, one of which is visible in Fig. 1.

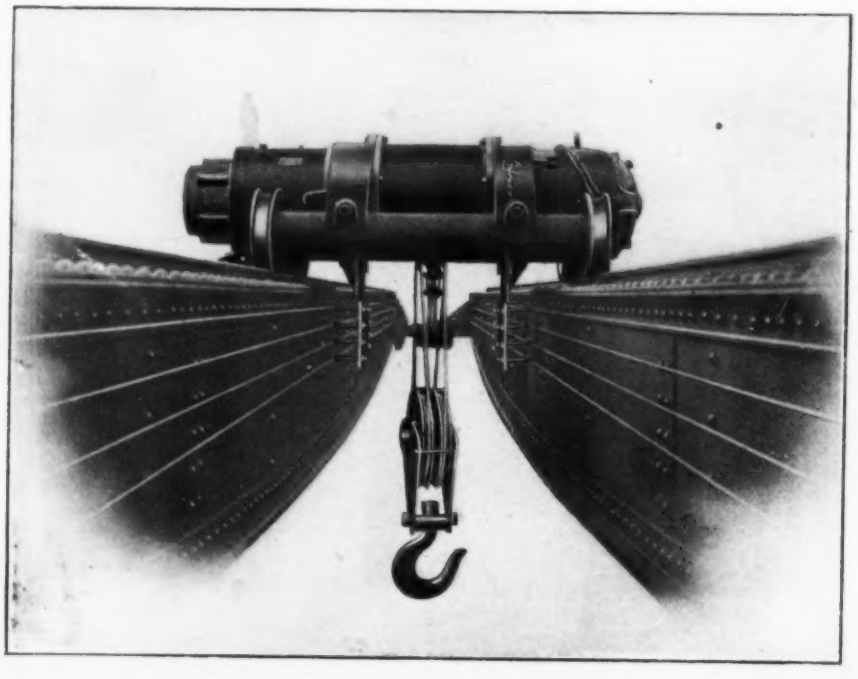


FIG. 1. TROLLEY FOR TEN-TON TRAVELING CRANE

The Gearing

The large casting at the opposite side of the trolley from the motor contains the very ingenious load brake and hoisting gearing, which is an interesting example of planetary gearing, a class much discussed of late in these columns. The gearing, except the two internal gears, is shown removed in Fig. 2, and partly separated in Fig. 3. In the former, at the left, is seen the seat for the magnetic brake; next to the right are the rings of the load brake, and just beyond is one of the planets (*B*) of the compound train which operates the load brake; still farther to the right may be seen the two planets *F* of the hoisting train. The gears may be better seen in Fig. 3. The whole train is driven by a central shaft from the electric motor at the other end; this shaft carries a pinion *A* meshing with the planets *B*; with the latter turn pinions *C*, which mesh with an internal gear capable of rotation in a small arc only, the result being to cause rotation of the cage *D* carrying *B* and *C*. To this cage is fixed the pinion *E*, meshing with the planets *F*, which also mesh with a fixed internal gear. The cage in which *FF* are mounted carries the sleeve *G*, which directly drives the hoisting drum. Thus both planetary trains play a part in giving the speed reduction, and the first one serves also to apply or release the load brake according to the direction of rotation. This is accomplished by the small rotative motion of the internal gear (not shown in the illustration) outside the cage *D*. This carries cams giving it an endwise motion sufficient to put pressure on the brake rings. The whole mechanism runs in oil, which also lubricates the magnetic brake rings, though the magnet-winding itself is protected from the oil. This plan gives a very compact arrangement of gearing, with balanced drive, that is, the work is divided between gears diametrically opposite, taking side pressure off the shaft and its bearings. The parts may be readily withdrawn for inspection or repair.

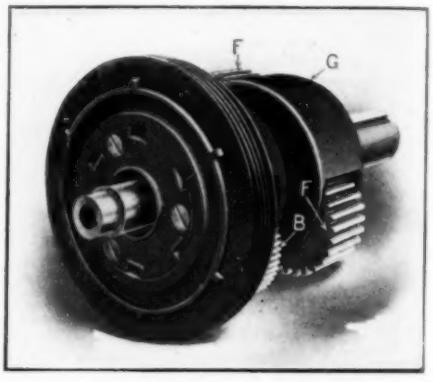


FIG. 2. THE RUNNING PARTS OF THE HOIST GEARING

The friction surfaces of the brake are at rest while the load is hoisted, so the brake is not then consuming power. The brake surfaces are bronze and iron. Of course, the load will not descend unless impelled to do so by the motor, and it cannot run faster than the speed due to the impulsion of the motor.

The movement of the trolley along the

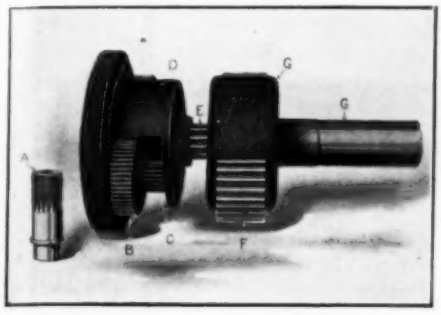


FIG. 3. LOAD BRAKE RINGS, COMPOUND AND SIMPLE PLANETARY TRAINS PARTLY SEPARATED

crane bridge is obtained through a train of spur gears, effecting two speed reductions, carried in an oil- and dust-tight case having no projecting shafts; hence there is no point at which oil can leak from the case, or dust enter. All of the gearing is mounted upon shafts supported by the case at each end, and it may be operated with the cover of the case removed, allowing inspection of the parts while in motion.

The arrangement of the bridge motor and gearing, which are usually located

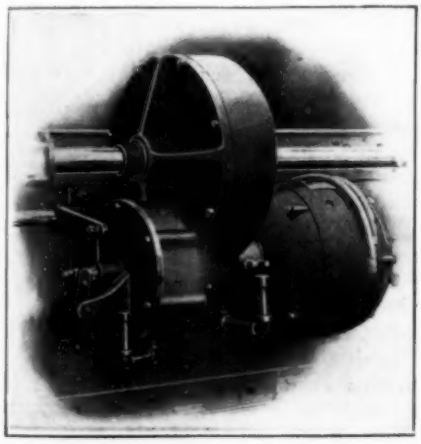


FIG. 4. BRIDGE TRAVEL MOTOR, GEAR CASE AND BRAKE CONNECTIONS

about the center of the span, is shown in Fig. 4. As in the case of the trolley, the gears are mounted in an oil-tight case, which carries the bearings, although in this case it is of course not possible to prevent the shafts from projecting through the case. The gear case also supports the motor and maintains it in a correct position relative to the bridge shaft, and there is but a single set of bolts attaching these parts to the bridge girder so as to carry their weight. This case also is provided with a cover which may be removed and the gearing operated with the case open.

The gears at the outer ends of the bridge shaft are also inclosed in cases, though in this instance not running in oil; this arrangement is shown in Fig. 5, which also illustrates the connection of the

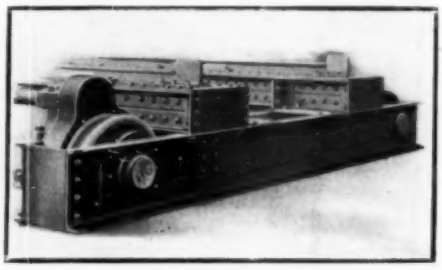


FIG. 5. END OF BRIDGE AND TRUCK, SHOWING GEAR-CASE

bridge girders and bridge trucks, the framing of the latter entirely surrounding the track wheels. The truck-wheel gears are bolted directly to the truck wheels; nevertheless the latter are keyed to their axles.

There is a brake on the bridge travel which is applied by means of a spring and requires the pressure of the operator's foot upon a pedal in order to release it. This brake acts upon the bridge motor pinion and its connections may be seen at the left of Fig. 4. This brake, like the other brakes on the crane, runs in oil and is made of anti-friction material, which the manufacturers consider to be the most satisfactory for this purpose.

Another safety device is the automatic limit switch which is mounted upon the trolley. When the hoist hook reaches the upper end of its travel, this switch opens the circuit of the hoist motor, thereby preventing over-winding.

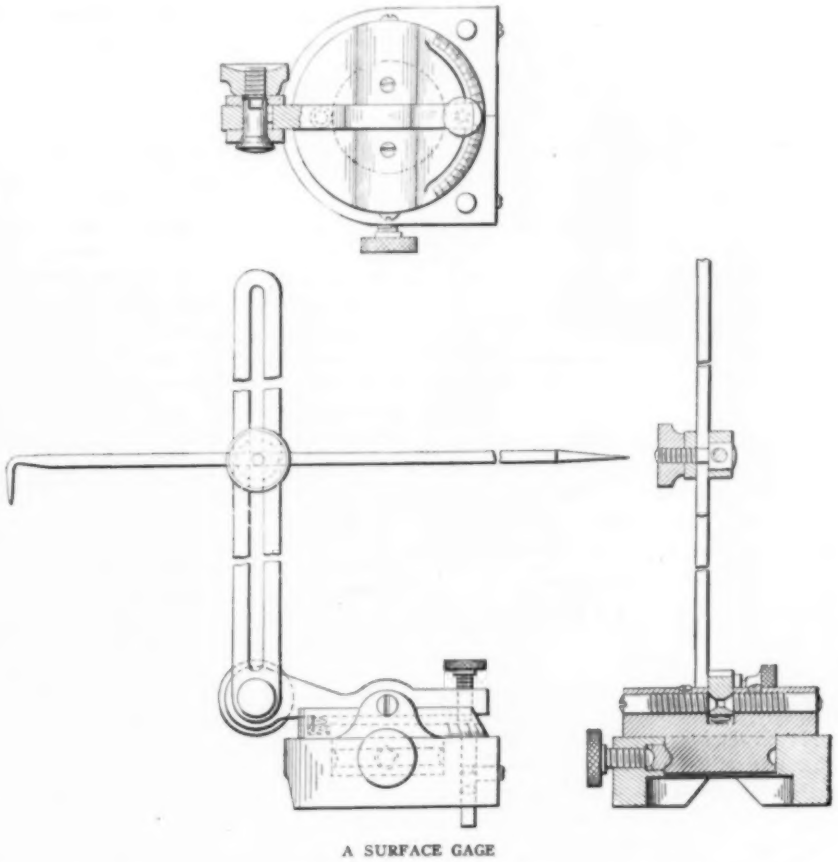
In this crane wire rope is employed for the hoisting cable.

The motors employed are of the interpole type, these being used in order to obtain a better accommodation of the speed to the load lifted, it being claimed that the interpoles neutralize the distorting effect upon the field of the widely varying armature reaction due to widely varying current strength; hence neither light loading with a corresponding acceleration of speed, or even over-loads with a corresponding drop in speed, sensibly affect the commutation, which is said to be sparkless under these varying conditions.

These cranes are built by the General Pneumatic Tool Company, Montour Falls, New York.

A Surface Gage

The illustration shows a surface gage which has recently been patented by



A SURFACE GAGE

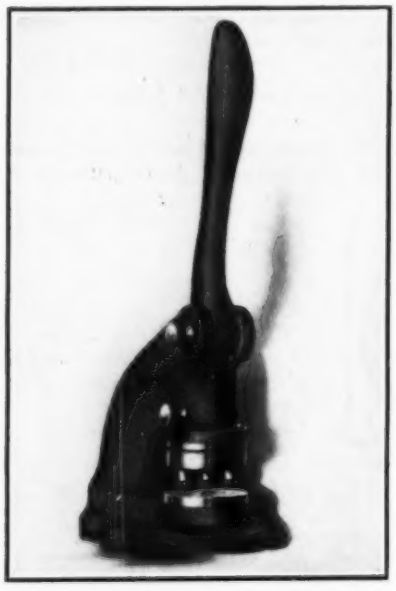
Thomas Evans, of Great Falls, Montana. The principal feature of this gage is the rotary turntable, supported in a base and carrying a scriber; no matter at what

angle the table is turned, the point of the scriber will always be in a plane in which is the axis of the turntable, thus enabling a machinist to set with ease many jobs that are now difficult to set with the ordinary surface gage.

A Punch for Making Washers

The illustration shows a press and dies for making washers of leather, rubber or other soft material.

The lower plate is of brass with rings of soft metal let into it. The edges of the hollow punches coming in contact with these soft-metal rings, after passing through the material from which the washers are made, are not injured. In the center of each of the soft-metal rings is a hole into which the punch works which punches out the center of the washer. The punch for the center hole is slightly in advance of the hollow



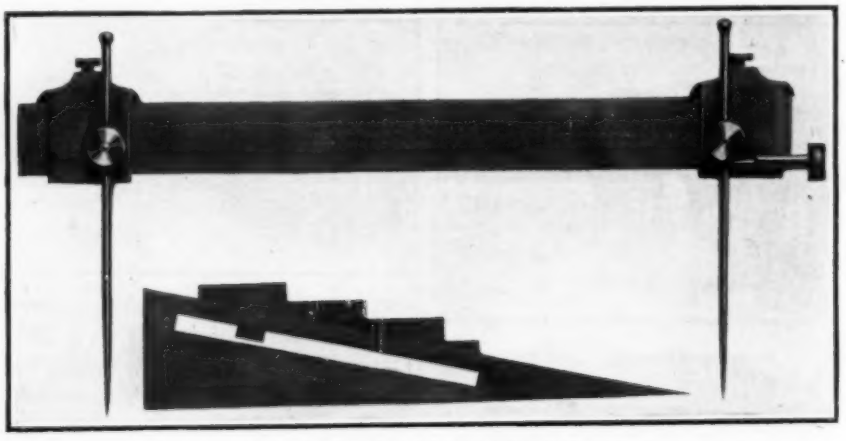
A PUNCH FOR MAKING WASHERS

punch. Suitable knock-outs are provided, as the washers are usually retained in the hollow punches. This device was invented by August Lidovic, 368 Connecticut street, San Francisco, California.

Tram Points and Hight Gage

The trammel points shown are simple, easily adjustable and ought to be very handy in laying out large work. The points are adjustable vertically and locked firmly by drawing them against the round block by the thumb nut and screw bolt. The point at the right is also controlled by the adjusting screw, which gives a fine adjustment in either direction to secure the exact setting. As shown, it is moved to the extreme right. It is also adjustable vertically the same as the other. Caliper points are also supplied for use when measuring large work, and the larger size trammel points are made to fit a wooden beam.

The hight gage shown below the trammel points hardly needs a description, as its use is self-evident. It was designed for such work as setting a planer or boring-mill tool, but will be found handy in many other places.



TRAM POINTS AND HIGHT GAGE

These tools are made by Charles Hallstrong, 17 Caldwell avenue, Somerville, Massachusetts.

Winning Out on a Patent

By William M. Clark

Twenty years ago Jack Davis found his way out of the woods. Jack was a conscientious, all-round machinist who inherited an inventive instinct from away back. He had contrived a number of novel devices, none of which, however, had brought him very tangible returns. I first met him, a slim, nervous young fellow, when acting as foreman in a shop where I was having some strenuous mechanical experiences. Ever since we have been on terms of intimacy, and his winning out on a patent may prove an object lesson for the ambitious young mechanic.

Two or three years after I first knew Jack, he went to work for a concern that manufactured a sewing-machine attachment for making up knit underwear. This device automatically trimmed the seams of garments very neatly, quite near to the line of stitches. It was done by a pair of tiny scissors set close behind the needle, which continuously clipped away the waste fabric during the process of sewing. The manufacturers had secured a patent on the scissors arrangement and seemed to be doing well. They were in some way backed by the Skinner Trading Company, upon whose sewing machines the attachment was exclusively used.

But Jack found out that the clipped edges of the fabric, so close to the seam, proved harsh and irritating to the skin, and considerable complaint was made by dealers about garments sewed and trimmed in this manner. True to his inventive instinct he began to look for a way to make a better seam. There was a demand for something different. He worked over the problem for months, but had arrived at no satisfactory results. There was a dim idea floating around in his brain, but it would not materialize and he was becoming discouraged.

One day a man was sent out from the shop to a near-by factory to look after some machines that needed repairs. Before going, he gathered up a bunch of tools to take along. These he wrapped and tied into a secure package and was looking for a knife to cut the stout cord he had used.

"Chuck your knife over to me a moment," he called to Jack, who was at the next bench. Jack felt in his pockets but his knife was missing, and he answered back, "Chew it off, Jim."

"All right, Smarty, I will." He placed the loose end of the cord over a vise, struck it a sharp blow with a hammer held at an angle, and the stout twine fell apart.

Jack had done the same thing a hundred times. But this time the action had a peculiar significance. In a flash the vague idea in his mind materialized, and a way to trim a seam without scissors appeared to him.

He nursed his discovery carefully and that evening, at home, began experimenting again. It was two or three months before he had completed a working model that "chewed off" or separated the fabric by compression, close up to the stitches. He attached it to his wife's sewing machine and it worked perfectly, making a seam as soft and agreeable as any other portion of the garment.

But Jack was not yet out of the woods. He had only found a rocky path which led in the direction he wished to go. He had something laid by against a rainy day. But inborn prudence protested against disturbing this reserve to promote a mere in-

vention. Money is as scary as rabbits upon the approach of an inventor. Even his own money was frightened at him. But a patent was absolutely essential. He had guarded his contrivance carefully; still it might leak out or someone else stumble on the same thing, and he would lose it after all. He felt sure there was nothing like it in use. He had gone far out of the old scissors way of trimming a seam, and had tested it to the highest speed of a sewing machine. It was certainly worth risking at least a part of his rainy-day reserve upon, a decision arrived at after some weeks' hesitation and heartily approved by his wife.

There was nothing found to interfere in a preliminary search by his patent attorney, who was particularly enthusiastic over the outcome and encouraged Jack to believe that if they didn't run up against something in the Patent Office not yet issued, the way was clear for a broad claim.

The mills of the Patent Office grind slowly. Three or four months passed before the examiner reached the case. Then he threw a bomb-shell into Jack's path. A similar device, not yet allowed, turned up, that antedated Jack's only two or three weeks. The thing that Jack feared had occurred during his indecision. Another had stumbled on the same thing, or else his invention had leaked out and someone else had gotten ahead of him.

Mr. Campbell, his patent lawyer, promptly notified the Patent Office that he would contest the priority claim, and called upon Jack to find at least one disinterested and trustworthy witness to support him.

Jack had been so secretive in the matter that he could not recall anyone who had seen his device or to whom he had spoken about it.

"Well, think it over," said Mr. Campbell, "perhaps you may remember someone we can call upon. We must be able to establish definitely an anterior date. If we can do that, our way is clear for a patent."

In the meantime a master was appointed to hear the testimony, upon whose report the examiner's decision would be made. Within a week the case would come up. Jack had yet no one to corroborate his claim that the actual construction of his device had been worked out some months before the date of his application for patent.

Then something happened. Going to lunch one day, Jack met Jerry Symons, an old shopmate whom he had known for years, but had lost sight of for several months. After the usual greetings Jerry blundered out, "How is the patent coming on, Jack?"

"Patent! What do you know about my patent?"

"Don't you remember the night I called at your house to get you to say a good word for me at Craig's?"

"Why, Jerry, I had forgotten all about it until this moment."

"Well, I didn't forget, Jack. I made good money at Craig's until my failing, you know"—raising his elbow and bringing his hand to his mouth—"got the best of me again. You were puttering away over a sewing-machine contraption that evening, and while you didn't explain it to me specially you started up the machine, which trimmed off the edges of the cloth as it was sewed, just as neat as wax. You showed me afterward that the seam was as soft as velvet. It doesn't take an old toolmaker who's been around machine shops all his life very long to see how a thing works. Why, it was great. You had the scissors attachment beaten a mile. But, honest, Jack, I never whispered a word about it to a soul."

"How long has it been since you saw it, Jerry?"

"It must be five or six months. I got the job at Craig's and went to work next day, and the time-keeper there can give me the date to the hour."

"Well, come with me and let's get lunch some place where we can talk, and I'll tell you the whole story."

After a long talk and a good dinner Jerry accompanied Jack to Mr. Campbell's office, where he submitted to a rigid preliminary examination as to his construction knowledge of Jack's device and the fixing of a prior date. The master's report to the Patent Office resulted in the issuance of the patent to Jack.

But another formidable boulder appeared across Jack's path. After he received his patent he opened negotiations with a Mr. McFarland, who hailed from the West. He was past middle age, flourished long, auburn side whiskers, was largely interested in various enterprises and bore the reputation of being at least a half a millionaire. Besides he looked as if he were a fighter. The plan in view was to place the new trimmer into the hands of manufacturers, who, instead of buying the attachment outright, should be required to pay a monthly royalty or rental for its use. McFarland was to furnish sufficient capital to equip a plant with facilities to make the trimmers and supply the demand. The royalties received were to be shared equally. But definite arrangements had not been made.

Then a representative of the Skinner Trading Company called to see Jack.

"I wish to talk over a late patent issued to you," he began. "You may not be aware that we own a device which is practically the same thing."

"Is your device in use anywhere?" inquired Jack.

"Well, no; we consider it of little value for factory purposes—too slow and uncertain in its action. We took it over from the patentee for a small sum, as we do most sewing-machine attachments offered to us. You ought to see our collection."

"You say this trimmer you have is slow and uncertain. Then it is unlike mine, which is rapid and trims clean and sure."

"Would you object to showing me your attachment?"

"I am sorry I haven't it here today."

"Well, it is immaterial. Our experts have thoroughly investigated your patent and I am instructed to say that any attempt to place it on the market will be met by prosecution for infringement. However, as you have been at some expense in the matter, we are willing to take your patent over, as we have done in other instances, and pay you a nominal price, say $300, for the assignment of the entire right, title and interest in same. If you decline our offer, and in the event of your disposing of a single attachment, we will begin suit, simply to protect our manufacturing rights. I am ready to close with you today. Tomorrow my proposition may not be so favorable.

Does an Irishman hate snakes! Well, so did Jack hate lawsuits. He thought fast. He had no money to fight the Skinner people. It was not likely that McFarland would go any farther. He wasn't buying lawsuits. Hadn't he better take what he could get? The amount would about make good what he had spent on it. But Jack put up a bold front and replied:

"We had best let the matter rest for the present. If you care to call in tomorrow, do so. I'll be here all day."

After the Skinner man had gone, Jack suppressed an impulse to call him back. Then he caught his second breath and resolved to see Mr. McFarland and lay the whole matter before him. If he turned him down, he still had the Skinner people.

McFarland listened calmly to Jack's recital of the Skinner proposition. Then he said:

"They tell you they have the same thing and it's no good, yet are willing to pay $300 for another one. They want you to believe that they are bald-headed philanthropists. To me it looks like a game of bluff. If you are willing we will close our deal on the terms practically agreed upon. Then when that smart duck comes in tomorrow, tell him you have considered his proposition to buy your patent and that your price is $25,000. As to his threat to sue for infringement, say that you have taken steps to defend your rights. If they have anything like your trimmer, we will compel them to bring it out."

The substantial value of a patent is usually greatly enhanced when the validity of its claims has been sustained by a court of justice. To hasten such a test of Jack's invention, Mr. McFarland had a few trimmers made. These he placed on sewing machines in a factory where the scissors device was in use. The ruse was successful. Within two or three weeks, suit was begun by the Skinner company for infringement and damages. This trial was mostly a battle between lawyers and experts. Jack was the principal witness

in defense of his invention, his testimony, however, being turned against him on several hours of irritating and malignant cross-examination by the Skinner company's lawyers. While Jack vowed he would thrash those two lawyers within an inch of their lives, when he caught them outside, he kept cool, sometimes proving as caustic as his inquisitors. When he left the chair, Mr. McFarland reached over and whispered:

"You did bravely, my boy. They haven't a leg to stand on. Our case is as good as won."

And so it was.

Instead of thrashing those maligning lawyers, Jack, at Mr. McFarland's suggestion, addressed a note to the Skinner people, thanking them for their action against him; that the results of their suit had given a boom to his invention among the manufacturers, which $10,000 spent in advertising would not have done.

Jack is out of the woods. Long ago he removed from the little $10-a-month house that sheltered his family for years. In his new and handsome modern home in the suburbs, prosperous and portly, he smoke his pipe in peace.

Training Workmen

BY P. BURLING

The article "Commercial-training Workshops," by Chas. Prescott Fuller, on page 389, is a point well taken and should be read with interest by employer and employee.

I have had no personal experience as an apprentice in any shop at any trade, but like Topsy "just growed." More on this account than any other I feel prompted to write on this subject as viewed over the fence from the outside, from which viewpoint come most of the gibes and jeers that are hurled at any good move, moral, social or mechanical.

I have in mind a young man who was employed in one of our locomotive shops, who did nothing for several years but turn crank-pins. He started in to learn the trade of a machinist, but the longer he stayed at his job the harder he seemed to be riveted into the hole for the crank-pin; he finally resolved to get out before he became so battered in and rusted fast that a cannon would have to be used to fire him out. He is now pursuing another trade with reasonable success.

The personal influence or pull that has been used to boost a poor mechanic up, and the personal enmity that has been used to keep a good one down, are shop differences that may and apparently do appear as small matters in the eyes of some managers; but they gnaw at the very vitals of any business, morally, physically and commercially. Anything that will cut this out or retard its growth will be a move in the right direction.

A direct application of the golden rule is about the only thing that will bring these things down to a perfect level, but we have not the nerve to apply it or live by it if it were applied; consequently in the present trend of our business methods and sympathies we are ready to fall in with nearly everything that looks fairly good. Men and boys have different dispositions, and the shop will probably have to contend with them as long as they mingle them with their work and fellow workmen; but a well-regulated commercial-training workshop should go a long way toward leveling down all of these evil tendencies, to some extent at least. Not that it makes any practical difference whether a man gets his knowledge of the essentials of mechanics in a technical institution, or by hard knocks and dirty grease in a direct and practical manner. The trouble is the latter process does not appeal as strongly as the former may to the majority of boys after a trade; but after having passed the said training, they are more likely to be good fellows to each other and display a more even disposition by reason of the more healthy atmosphere that is likely to be the environment of such a training. Of course, most of this depends upon the trainer. A trainer that cannot get along with a few bad boys is not fit to train good ones. It has long been my opinion that it would pay any large machine company that takes boys to learn a trade to employ one or more good trainers at a good salary, to have no other duty than to educate the boys to the trade, and thus leave everybody with nothing to do but to attend to his own business.

Personal

Walter B. Snow, for many years connected with the B. F. Sturtevant Company, and manager of their publicity department, has resigned, and opened offices at 170 Summer street, Boston, Mass., as a publicity engineer. He will do work of all kinds in the way of publicity for the manufacturers of machinery and allied products.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free.E.G.Smith Co., Columbia, Pa.

Automatic machinery designed and built. Geo. M. Mayer, Elkhart, Ind.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Clockwork and clock-operated mechanisms. Larchmont Mfg. Co., Larchmont, N. Y.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Special machinery and manufacturing plants. Albert Pott M. E., 23 Platt St., New York.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Orders in quantities for brass castings from ¼ to 2 lbs .in weight. Box 454, AMERICAN MACHINIST.

Contract machine work; tools and dies to order; complete modern equipment. Northwestern Machine Co. Detroit, Mich.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—Energetic steel or machinery salesman as manufacturing partner in central States. Box 497, AMERICAN MACHINIST.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Expert instructor, wants limited number of students in mechanical drawing, by mail. For particulars address Box 85, Annapolis, Md.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if its "right." Roy Machinery Co., Minneapolis, Minn.

Apprentices and others wanting to pass examinations as licensed engineers need Tulley's Handbook on Engineering. A library in one volume of 1000 pages, $3.50. Hill Publishing Co., 505 Pearl St., New York.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Investments that pay, the books that give you more knowledge than your job requires; we can tell you the ones you need if you tell us your specialty; send for our 168-page catalog. Hill Publishing Co., 505 Pearl St., N. Y.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Wanted—High-grade machine work, especially for screw machines and turret lathes. We can refer to a very well known line of high-grade tools now on the market to demonstrate that we are able to do the highest grade of interchangeable work. Box 386, AMERICAN MACHINIST.

Arrange with us to do your manufacturing; we are thoroughly equipped for all class of machine work, including screw machines and punch parts, tools, jigs, etc.; we design and build special and experimental machinery, also automobile and marine gasolene engines. Forest City Specialty Manufacturing Co., of Rockford, Ill.

In evenings, invent for profit; might expect mere lawyer to write articles for AMERICAN MACHINIST, as to win saleable patents on machines; no Patent Office Examiner nor other attorney is member both A. S. M. E., and A. I. E. E.; mail invention for free advice, estimate and pamphlet. E. P. Thompson, M. E., Registered Patent Attorney, 53 Morningside Ave., West, or 39 Cortlandt St., New York.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

COLORADO

Intelligent and experienced young man with knowledge electricity, mechanics and

accounting; successful record as cost clerk, factory accountant, salesman, branch office manager, sales manager with high-grade machinery houses; now employed in the West; seeks executive position with young and vigorous manufacturing company located in the East; wants part salary, part interest in the business. Address, with details "B," Box 484, AMERICAN MACHINIST.

ILLINOIS

Foreman toolmaker with an extensive experience at designing and constructing special machinery and tools for manufacturing purposes. Address "Reliable," AMER. MACHINIST.

A first-class up-to-date toolmaker with 15 years' experience on tools and tool designing, desires position of trust; 3 years' in charge of toolroom; first-class references. Box 522, AMERICAN MACHINIST.

Position wanted as foreman by A-1 machinist and toolmaker, technical educated, 30 years old; designer of special machines, tools, dies and fixtures for cheap and accurate production; first-class references. Box 514, AMERICAN MACHINIST.

MASSACHUSETTS

Assistant superintendent wants position with growing concern; designer of special machinery, jigs, tools; a cost reducer and systematizer; salary $30. Box 511, AM. M.

MICHIGAN

Foreman screw machine department; 30, married; desires change; thoroughly up to date on Jones & Lamson and Warner & Swasey turret lathes; 11 years' experience on electrical, automobile, etc. work; 3 years in charge; not afraid to take off coat and hustle; will go anywhere, South or Middle West preferred. Address Box 512, AM. M.

NEW JERSEY

Automatic and special machinery designer; age 36; 20 years' shop and drafting room experience; first-class ability; salary $2000; at liberty Dec. 1. Box 489, AMER. MACH.

NEW YORK

Mechanical draftsman wishes position. Address Box 517, AMERICAN MACHINIST.

A thorough mechanic, possessing good business ability, is desirous of representing manufacturing concern or taking charge in factory; age 29. Box 524, AMER MACH.

First-class designer of steam engines, marine and stationary, blowing engines, air compressors and general plans; desires position; ten years' experience; first class references. Box 520, AMERICAN MACHINIST.

Experienced designer of special automatic machinery, tools, dies, jigs and fixture for cheap and accurate production, desires to change; 32 years of age; executive ability; best of references. Box 523, AMER. MACH.

American, mechanical engineer, twenty-nine, seven years' experience on machine tools and hoisting machinery, wishes to change; location preferred, New York or Pennsylvania. Box 481, AMER. MACHINIST.

Man of ability, with technical training and experience in mechanical, electrical and commercial work, wishes permanent connection with reputable concern in New York City; engineering or executive position. Box 479, AMERICAN MACHINIST.

Machinist and toolmaker, expert in all mechanical branches; 16 years' experience, 5 years' foremanship experience, inventive, special labor saving devices, etc.; wants responsible position; highest references. Box 513, AMERICAN MACHINIST.

Position wanted as superintendent or head foreman by technical and practical man; 35 years of age; expert mechanic, designer of special machinery and tools, dies, jigs and fixtures for cheap and accurate production. Address "H. K.," AMERICAN MACHINIST.

Mechanical engineer; member A. S. M. E.; varied experience; general manager of machine, foundry and forging works for many years; would consider a proposition to represent any good line in New York City either with or without investment; principals only. Address "Mechanical," Box 501, AM. MACH.

Position as assistant superintendent or mechanical engineer; up to date on modern production, special and standard machine tool design; 34 years of age (married); technical education; 15 years' shop, designing and commercial experience; executive ability, desires to change, highest reference. Box 505, AMERICAN MACHINIST.

Machinery salesman or local exclusive representative, special and standard tools, technical education, creative and executive ability; 15 years' shop and designing experience, including five years traveling in New England States, New York and Pennsylvania; desires change; open for engagement Jan. 1; 34 years of age, married; highest reference. Box 506, AMERICAN MACHINIST.

PENNSYLVANIA

Production engineer; specialty organization; modern cost accounting; jig and fixture design; desires change; highest references. Address "Cost Reducer," AMER. MACH.

Designer with practical machine shop experience, familiar with paper bag, envelope and other automatic machinery; good executive ability; salary $2400; at present superintendent of shops. Box 515, AMER. MACH.

Wanted—Position as plant engineer, or as designer of special machinery for reducing cost of production, familiar with steam and gas engines and medium automatic machinery; at present superintendent of shops; salary $2400. Box 516, AMER. MACHINIST.

RHODE ISLAND

Draftsman of several years' experience wishes position. Box 504, AMER. MACH.

Draftsman, 27, wants position; wide experience on automatic and special machinery, tools, etc.; 4 years' shop and foundry, 7 years drafting; excellent references. Box 498, AMERICAN MACHINIST.

Draftsman now employed with ten years' experience in shop, as toolmaker, three as foreman, and six years designing high-class tools, special and automatic machinery, desires change; competent to take charge. Box 510, AMERICAN MACHINIST.

WISCONSIN

Mechanical and electrical engineer, familiar with electric crane design, desires change, experienced in sales and executive branches, capable of filling position of chief or managing engineer. Box 502, AM. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—Machinists; one Jones & Lamson screw machine operator, two boring mill, two planer hands and two fitters; steady work and good wages to first-class men. Farrel Foundry & Machine Co., Ansonia, Ct.

Wanted—First-class automatic screw machine operator; one who understands the Hartford horizontal turret preferred; also man to take charge of a mixed line of hand machines. Address The Standard Mfg. Co., Bridgeport, Conn.

Wanted—Machinist and toolmaker thoroughly grounded in mechanical principles, for light experimental work; one expert to set up hand screw machines; several subforemen on milling machines, drill presses and gear cutters. Box 519, AMER. MACH.

ILLINOIS

Wanted—Machine tool salesman acquainted with Wisconsin, Indiana and Illinois territory, to handle metal working machine for an eastern concern. Address up to Oct. 22, "M. A. C.," Great Northern Hotel, Chicago, Ill.

INDIANA

Wanted—First-class blacksmiths in wagon department; give experience and wages wanted, with application. Address Supt. Wagon Dept., Studebaker Bros. Mfg. Co., South Bend, Ind.

Wanted—First-class foreman thoroughly versed on die and machine work, such as bulldozers, drop and trip hammers, punch, shear and trimming machines of all kinds, also forging machines, to forge and shape irons for farm wagon gears; state age and experience. Address Supt. Wagon Dept., Studebaker Bros. Mfg. Co., South Bend, Ind.

KENTUCKY

Wanted—Business manager for machine shop, representing an investment of $100,000 in a city of 175,000 inhabitants, located in Ohio; desire man who can invest $10,000. Address, with references, "Manager," Box 442, AMERICAN MACHINIST.

NEW JERSEY

Wanted—An assistant mechanical engineer for a large textile plant; technical graduate with shop experience, preferred; age 25 to 30; good salary to the right man. Box 474, AMERICAN MACHINIST.

Wanted—Foreman for polishing and plating department; must be thoroughly experienced in the handling of nickel, brass and copper solutions, familiar with oxidizing in its various branches, have good executive ability, and fully competent to handle help; applicants should furnish references, and state salary expected. Address Box 518, AMERICAN MACHINIST.

NEW YORK

Cost clerk wanted in typewriter factory; must have experience and good record in this line. Box 507, AMERICAN MACHINIST.

Wanted—Two first-class wood pattern makers; good wages to the right men. Apply to Clark Bros. Co., Belmont, N. Y.

Salesman who has worked in machine shop to sell a tool of merit required in all machine shops; excellent opportunity for a hustler; state age, experience and salary expected. Box 521, AMERICAN MACHINIST.

Wanted—In the east a young man having a technical education and at least three years' practical experience in a good machine shop; some experience in selling would be an advantage; must be of good character and habits, straightforward in his dealings and ambitious to establish himself permanently; no application will receive consideration unless by hand written letter giving age, full name and home address, present place of employment, details of school and shop experience; a reasonable salary, permanent position and good prospects for the right man. All communications will be treated with strict confidence. Box 503, AM. MACH.

OHIO

Wanted—Draftsman, experienced on heavy machine tools, particularly boring mills above six feet; give experiences and salary wanted. Box 384, AMERICAN MACHINIST.

Wanted—First-class pattern shop foreman, on heavy machine work; must be good executive; give age, experience, references and salary expected. Box 508, AMER. MACH.

Wanted—First-class foundry superintendent for machine molding grey iron foundry of 50 tons capacity; the foundry is equipped in a strictly up-to-date manner; no hand molding; only green men employed; applicant must be strictly temperate in habits, of good character, aggressive and must possess an abundance of executive ability; full knowledge of all molding machines and best application of patterns is absolutely necessary; give full particulars and references; no cheap man need apply. Box 376, AM. M.

PENNSYLVANIA

Wanted—An experienced molder, familiar with cylinder work; give full details of experience and wages. The Shepherd Engineering Co., Williamsport, Pa.

Wanted—Energetic young machinery salesman with $5000,or more, to take interest in A-1 specialty; can be handled as side line. Box 509, AMERICAN MACHINIST.

Wanted—Mechanical draftsman, experienced in engine and generator work; one preferred who has had some experience in testing. Apply to Ridgway Dynamo and Engine Company, Ridgway, Pa.

On account of increased business we are constantly in need of high-grade planer, lathe and boring mill hands; also competent erectors; no labor troubles. The Blaisd'l Machinery Co., Bradford, Pa.

We are increasing our capacity and invite applications from all classes of strictly first-class machinists; steady work, good wages, open shop, nine-hour day; no labor troubles. Riverside Engine Company, Oil City, Pa.

Wanted—Foreman machinist as partner in prosperous Pittsburg jobbing shop; dies, stamping and special machinery; good man given chance to work for me few months before investing; splendid opportunity for right man. Box 475, AMERICAN MACHINIST.

Wanted—A first-class man as general foreman of brass department, manufacturing a general line of steam cocks, such as brass globe and angle valves, gate valves, steam cocks, etc., works located Western Pennsylvania; state age and experience. Box 476, AMERICAN MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

FOREIGN

Master mechanic; Swede; practical and thoroughly acquainted with modern machine shop practice and experienced in handling men, wanted at once for new shop in Sweden; one with experience from locomotive and iron works preferred; good chance for the right man; none but an energetic and fully competent man need apply. "Practical," AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

Nearly new bench lathe and tools. A. F. Wisner, 119 N. Norwood ave., Buffalo, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

Machine shop for sale; $3000 a year; owner died; big sacrifice for cash. Address Box 112, Georgetown, Colo.

For Sale—The valuable patents, stock, tools, equipment and good will of an established machinery business situated at Hartford, Conn. Address "Value," AM. M.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

Steam engine for sale; 250 h.p. Greene automatic cut-off, double-crank, non condensing, horizontal engine, size 16 inches by 42 inches, two cylinders, with band fly-wheel 14 ft. by 31 in., speed 75 r.p.m.; built by F. C. & A. E. Rowland, New Haven, Conn.; this engine is in excellent condition, and has been in regular service in our factory for several years, being displaced by electric equipment in the enlargement of our plant; it may be seen running until Oct 5, its use being discontinued after that date. Winchester Repeating Arms Co., New Haven, Conn.

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Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Globe Machine & Stamping Co., Cleveland, O.
Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Walker, N. U., Boston, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cleveland Twist Drill Co., Cleveland, Ohio.
Cochrane-Bly Co., Rochester, N. Y.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arches, Boiler Door

McLeod & Henry Co., Troy, N. Y.

Architects

Dodge & Day, Philadelphia, Pa.
Seaver, John W., Cleveland, O.

Barrels, Steel

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.

Bearings, Ball and Roller —*Continued.*

Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Main Belting Co., Phila., Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chains

See Hoists, Hand

Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.
Witteman Co., A. P., Phila., Pa.

Blowers

American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Ill.

Blowers —*Continued.*

Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.
Keuffel & Esser Co., New York.

Blue Print Paper

Keuffel & Esser Co., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Boiler Setting

McLeod & Henry Co., Troy, N. Y.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., East Hampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal

Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Wilmington, Del.

Boring and Drilling Machines, Horizontal—*Cont.*

Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Whitcomb - Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Boring Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Carr Bros., Syracuse, N. Y.
Fairbanks Co., Springfield, O.

Boxes, Tote

Cleveland Wire Spring Co., Cleveland, O.
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp

Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction

Electric Controller & Supply Co., Cleveland, O.

Brazing

Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers

National Machinery Co., Tiffin, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.

Cabinet, Tool—*Continued.*
Lyon Metallic Mfg. Co., Aurora, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
See Grinding Wheels.

Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Cast Iron Brazing
Reinforced Brazing & Mach. Co., Pittsburg, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.
Rowell Co., W. G., Bridgeport, Ct.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Berry & Parker, Erie, Pa.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Carr & Co., Stuart R., Baltimore, Md.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Keystone Steel Casting Co., Chester, Pa.
Manufacturers Fdry. Co., Waterbury, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Farrel Fdry. & Mach. Co., Ansonia, Conn
Kent & Co., Edwin R., Chicago, Ill.
Keystone Steel Casting Co., Chester, Pa.
Witteman & Co., A. P., Phila., Pa.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D .E., New London, Conn.

Centers, Planer
Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.

Chucking Machines—*Cont.*
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven. Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Electric Controller & Supply Co., Cleveland, O.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring
Adjustable Collet Co., Cleveland, Ohio.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Brunswick Refrigerating Co., New Brunswick, N. J.
Seymour & Whitlock, Newark, N. J.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Davis Machine Co., W. P., Rochester, N. Y.
Electric Controller & Supply Co., Cleveland, O.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Crane Pullers
Walker, N. U., Boston, Mass.

Cranes
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Portable Crane & Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

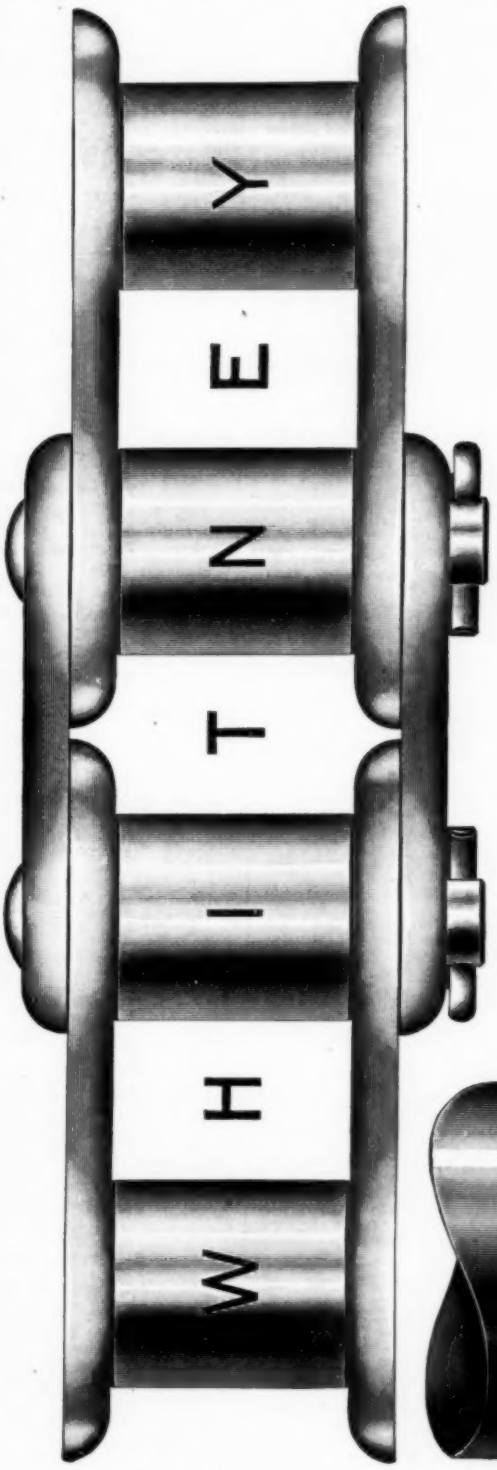
Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

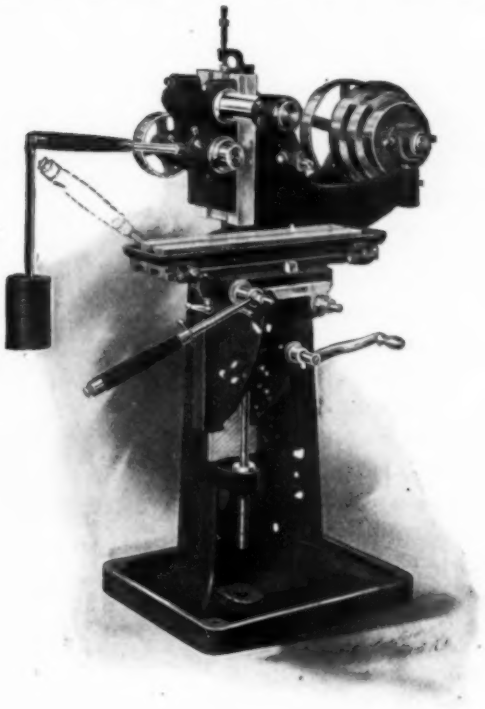
Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.
Winkley Co., Detroit, Mich.

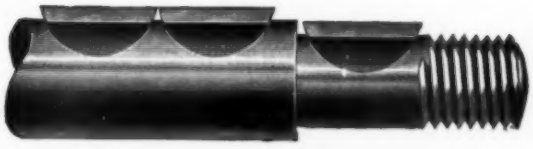
"WHITNEY" CHAINS

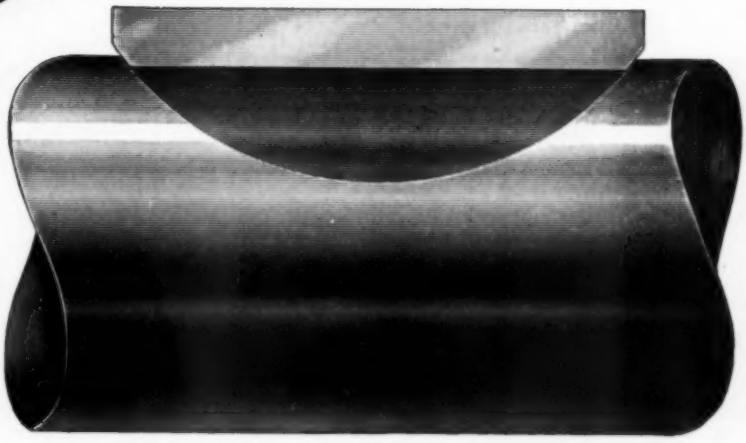
Hand (feed) Milling Machines
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Baldwin Steel Co., New York.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Wks., Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fairbanks Co., Springfield, O.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, Ohio.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.
Risdon Tool Works, Waterbury, Conn.

Dies, Sub-Press

Risdon Tool Works, Waterbury, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins

Winkley Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, O.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, O.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Chicinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret

Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.

Drills, Hand—*Continued.*

Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail

Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, Ohio.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madi-
Ridgway Dynamo & Engine Co., Ridgway, Pa.
son, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B .F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

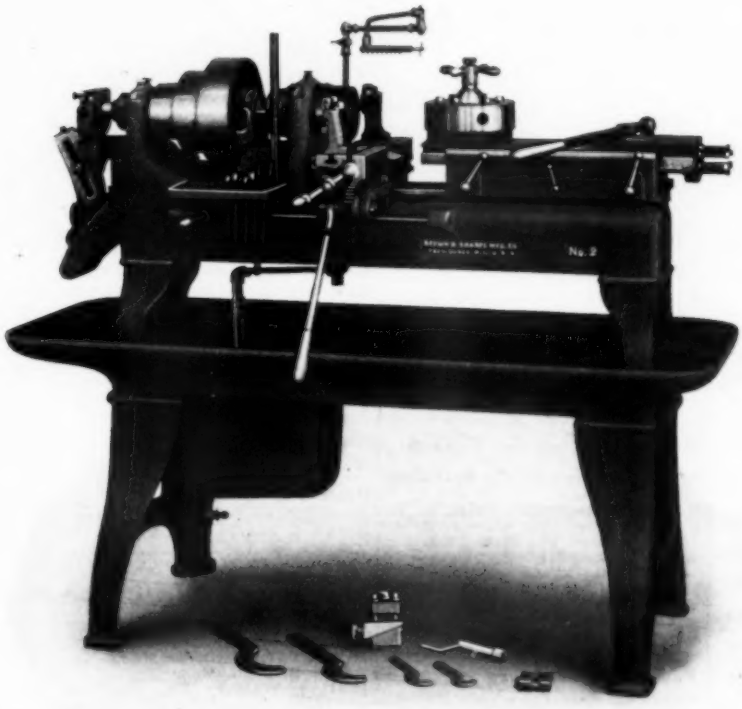
Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U. S. A.

No. 2 Wire Feed Screw Machine



CAPACITY: Hole through spindle, 1 5/16"; through largest collet, 7/8". Length that can be turned, 4". Swing over bed, 12 1/2"; over cross slide, 5".

The chief characteristic of this machine is the many features that save time in setting up and operating it. Independent stops are provided for quickly setting the tools in the turret. Scale on feed lever facilitates setting machine. Tool posts can be adjusted quickly. Cross slide can be operated by either screw or rack feed. Operation of chuck rapid and accurate by means of a lever on side of machine.

Circular sent to any address describing the machine in detail.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Consulting and Architect

Thompson, Hugh L., Waterbury, Conn.

Engineers, Mechanical and Electrical

Crocker - Wheeler Co., Ampere, N. J.
Dodge & Day, Philadelphia, Pa.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Engine Co., Stamford, Conn.

Engines, Oil

Remington Oil Engine Co., Stamford, Conn.

Engines, Steam

Buffalo Forge Co., Buffalo, N. Y. Ill.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric

Crocker - Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.

Fans, Electric—*Continued.*

Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Buffalo Forge Co., Buffalo, N. Y.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Fire Brick

McLeod & Henry Co., Troy, N. Y.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery

Scranton Co., The, New Haven, Conn.

Forgings, Drop

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Williams & Co., J. H., Brooklyn, N. Y.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic

Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine

Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel

Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Phila., Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.

Foundry Furnishings—*Cont.*

Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co, New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.
Witteman & Co., A. P., Phila., Pa.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester, City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam

Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gear Cutting Machinery—*Continued.*

Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Carey, Samuel, Glendale, L. I.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Foster Kimball Mach. Co., Elkhart, Ind.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Perikns Mfg. Co., Springfield, Mass.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

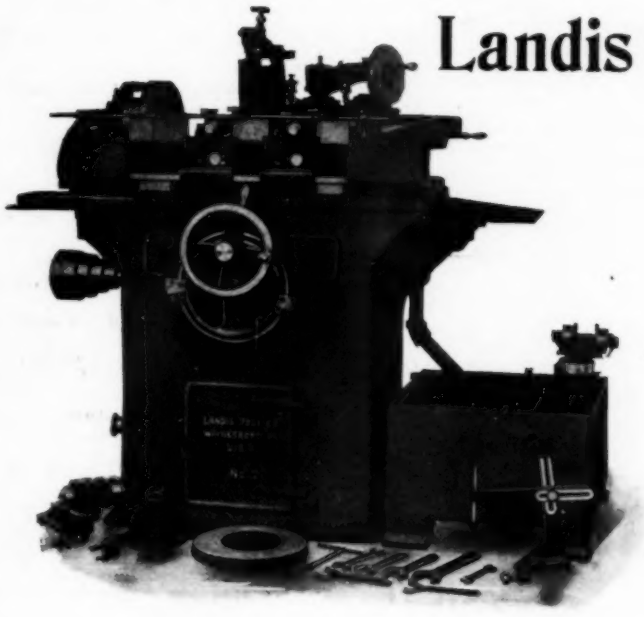
Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Carey, Samuel, Glendale, L. I.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets

Burke Electric Co., Erie, Pa.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Landis Grinding Machines



10″ x 20″

"LANDIS" No. 20 shown in the illustration is worthy of the name and is adapted for straight and taper cylindrical grinding wheels 12" dia. 1½" face. On our complete line of machines as well as the one represented here, vibration is practically eliminated. We will particularly call your attention to the simple construction. This is only one feature, there are many others, absolutely nothing to get out of order. All movements automatic, mechanism on feed up hand wheel to automatically size the work. This is the very machine you want, one that is sure to make good. We would like to make estimates on your work, or better still, send us some of your work as samples, we will agreeably astonish you with figures and results.

Landis Tool Company, Waynesboro, Pa., U. S. A.

AGENTS—W. E. Flanders, 309 Schofield Building, Cleveland, O., and 933 Monadnock Block, Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.

HUDSON

HIGH POWER

STEEL

BALDWIN STEEL CO., 133 Reade St., New York

Boston Chicago Pittsburg Philadelphia

All business men are interested in anything that cuts down the cost of production.

That's why so many know that it is advantageous to use Hudson Tools.

The output is increased without added expense, and time and labor saved by not having to rework and regrind the tools which do not deteriorate with constant use.

Generating Sets—*Continued.*
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas
American Gas Furnace Co., New York.

Gibs
Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Center
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Taylor & Fenn Co., Hartford, Ct.

Grinders, Drill
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
Thompson Grinder Co., Springfield, Ohio.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Independent Pneumatic Tool Co., Chicago, Ill.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw
Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co, Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cin., O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machinery
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Machry. Co., Cleveland, O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Gardner Mach. Co., Beloit, Mich.
Goodell - Pratt Co., Greenfield, Mass.
Graham Mfg. Co., Providence, R.I.
Greenfield Mach. Co., Greenfield, Mass.
Harding, S. B., Waukesha, Wis.

Grinding or Polishing Machinery—*Continued.*
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Thompson Grinder Co., Springfield, Ohio.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Wells Sons Co., F. E., Greenfield, Mass.

Grinding Wheels
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames
Athol Machine Co., Athol, Mass.
Cleveland Stone Co., The, Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.

Gun Barrel Machinery
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., The, New Haven, Conn.

Hammers, Steam
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.

Hammers, Steam—*Cont.*
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting
Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.

Hoisting and Conveying Machinery
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
United Engineering & Fdry. Co., Pittsburg, Pa.
Yale & oTwne Mfg. Co., New York.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker - Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineerng Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Chicago Flexible Shaft Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hones
Chicago Pneumatic Tool Co., Chicago, Ill.
Pike Mfg. Co., Pike, N. H.

Hose
Chicago Pneumatic Tool Co., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Rhoads & Son, J. E., Phila., Pa.
Sprague Electric Co., New York.

Design of Helical and Herringbone Gears

How Helical Gears Are Designed by Using Simple Formulas and Their Application to the Herringbone Gear Which Is a Twin Helical

BY CHARLES H. LOGUE*

For connecting parallel shafts where high speed and smoothness of action are essential, helical gears, of the general design as shown in Fig. 1, are far superior to ordinary spur gears. The smooth operation of this style of gear is due to the spiral action of the teeth, which affords continuous contact of one tooth with its mate, until the next is well engaged, thus transmitting uniform motion without variation in the impulses received by the driven gear.

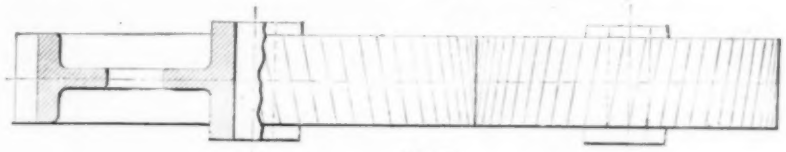


FIG. 1

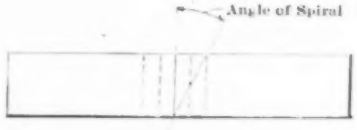


FIG. 2

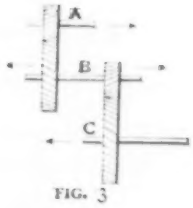


FIG. 3

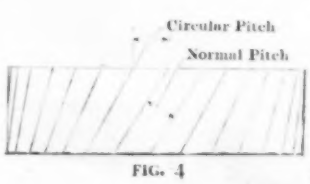


FIG. 4

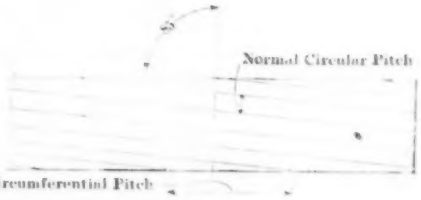



FIG. 5

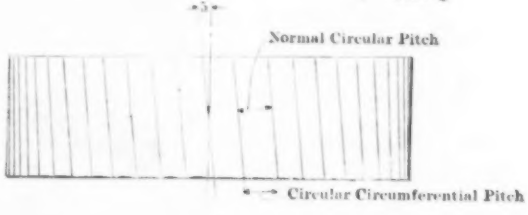


FIG. 6

THE DESIGN OF HELICAL GEARS

In the ordinary spur gear the teeth come into contact over their entire length at once, and the whole load comes on the top of the tooth with a leverage equal to nearly its depth, while in helical gears the strain reaches its maximum after the leverage has been materially diminished; an obvious advantage. The objection to these gears is the end thrust caused by the spiral action of the teeth; but when properly designed this may be reduced to a minimum. The highest efficiency is obtained by making the angle just great enough so that the end of one tooth will overlap the one adjoining. Therefore, it follows that the wider the face the less acute the angle need be and the less the thrust.

In Fig. 2 this angle is shown in such a way that a line drawn from the center of one tooth of a spur and at one edge of the gear will intersect the center of the space between it and the following tooth at the other edge.

If this circular pitch is 1½ inches and the face 10 inches, an angle of 12 degrees 41 minutes would be sufficient. Nothing would be gained by making the face any wider, except, perhaps, to accommodate the use of a standard cutter, which is often necessary when the speed ratio and center distance are fixed. Another reason for keeping the angle low is the fact that a steep angle, say, 30 degrees, will only allow points of contact across the face, depending of course upon its width, while a small angle will allow more of a line contact, as in spur gears.

Referring to Fig. 3 it will be seen that the thrust on the shaft B is entirely avoided and on A and C it is reduced to a minimum. The drive shown is often used to advantage where the gears are of necessity small and the drive heavy.

In the following formulas the circular pitch system is used throughout, as the introduction of diametral pitch would only tend to be confusing. When a diametral pitch cutter is to be used its circular equivalent should be introduced into the formulas. The "normal circular pitch" is the shortest distance between two consecutive teeth, measured on the pitch cylinder. The "circular circumferential pitch" is the distance between two teeth measured on the pitch line as in spur gears. See Fig. 4.

The following conditions govern the designing of helical gears: The pitch diameters must be in proportion with the number of teeth as in the case of spur gears. Therefore, the circular and normal pitch must be the same in both gears of a pair. The angle must be the same in both gears.

FORMULAS FOR HELICAL GEARS

Pitch diameter	D'
Outside diameter	D
Angle	E
Normal circular pitch	C''
Circular pitch	C
Lead of the spiral	L
Number of teeth	N
3.1416	π

1. $D' = C N \times 0.3183$.
2. $D = D' + (C'' \times 0.6366)$.
3. $Cos\ E = \dfrac{C''}{C}$.
4. $C'' = C \cos E$.
5. $C = \dfrac{C''}{\cos E}$.
6. The corresponding spur cutter $= \dfrac{N}{\cos^3 E}$.
7. $L = D' \pi \times \cot E$.

1. The pitch diameter is figured from the circular pitch in the same manner as for spur gears.
2. The outside diameter is found by adding to the pitch diameter twice the addendum of the normal pitch.
3. The angle of the spiral is always understood to be taken from the axis

*Mechanical engineer, R. D. Nuttall Company.

of the gear; therefore the gear with the smallest angle is nearest to a spur gear.

The angle is best determined by first selecting the pitch of the cutter to be used (normal circular pitch) and dividing it by the actual circular pitch; the result is the cosine of the angle. If this does not give the required angle the number of teeth must be changed, consequently the circular pitch, and another trial made, unless the diameter can be changed, which will change either the center distance or the speed ratio. When the angle is assured as well as the pitch of the cutter, the diameter necessary to give the proper combination may be found by first determining the circular circumferential pitch by formula 5, and then using the pitch thus found and the number of teeth in formula 1.

It may be well to state that the angle of the spiral for helical gears must be closely followed, as a slight deviation will cause the teeth to only bear on one end instead of evenly along the face. This condition also applies to the lead which must be closely followed.

4. The normal circular pitch is the pitch of the cutter used and may be found by multiplying the circular circumferential pitch by the cosine of the spiral angle. To avoid special cutters the normal pitch should conform as nearly as possible with some standard pitch. The normal pitch is generally assumed, and the angle made to suit. If there must be a variation between the pitch of the cutter used and the normal pitch of the gear it is better to have the cutter pitch less rather than more than the normal.

5. The circular pitch is found from the normal pitch and angle by dividing the normal circular pitch by the cosine of the angle. This must always correspond with an even number of teeth; that is, the circular pitch multiplied by the number of teeth must represent the pitch circumference of the gear in question.

6. After the pitch of the cutter has been settled the next step in importance is the selection of the proper cutter, as upon that point largely depends the success of the gears. The number of teeth for which the cutter should be made is found by dividing the actual number of teeth in the gear by the third power of the cosine of the spiral angle. It will be seen that the greater the angle the nearer we approach the rack tooth, as in a gear large in diameter with a small number of teeth, as shown in Fig. 5.

The less the angle the nearer we approach a spur gear, and the nearer the normal and circular pitch correspond, so that in a gear with a very slight angle, say, 5 degrees, as in Fig. 6, the same cutter is used as for a spur gear of the same size. It may be well to note here that for a gear such as is illustrated in Fig. 5, instead of using the regular No. 1 rack cutter made for 135 teeth and over, a straight-side worm-milling cutter be used. In fact this should be done when the value of formula No. 6 is found to exceed 250.

7. The spiral lead is the distance traveled by the thread in one complete revolution of the pitch circle and is found by multiplying the pitch circumference by the cotangent of the spiral angle. The lead begins at an angle of 90 degrees and increases as the spiral angle decreases until at an angle of 45 degrees it is equal to the pitch circumference of the gear, and, as the angle becomes smaller, the form of the tooth approaches that of the spur gear and the lead becomes longer until it gradually lengthens to infinity for a zero angle.

Let V = number of threads per inch of the lead screw.

Let T = number of teeth in the worm wheel.

Then the ratio of the change gears =

$$\frac{Lead \times V}{T}.$$

As V is generally made equal to 4 threads per inch, and T to 40 teeth, our formula becomes:

$$\frac{Lead \times 4}{40} = \frac{Lead}{10}.$$

Examples in the Design of Helical Gears

When computing a helical gear drive we generally have three conditions to meet, which are: the speed ratio, the center distance and a suitable angle. This angle should not exceed 20 degrees, but it is sometimes necessary to take the best we can get in order to meet the other two conditions. For example, suppose we desire a pair of gears as follows: Velocity ratio 4 to 1, center distance 12½ inches, and to be cut with a 4-pitch cutter. First arrange a table, as shown below. Then figure out the dimensions as they are listed.

Gears for.....
Center distance, 12½ inches.
Kind, helical.

	Gear	Pinion
Pitch diameter	20	5
Pitch circumference	62.832	15.708
Number of teeth	76	19
Circular pitch	0.8267	0.8267
Normal circular pitch	0.7854	0.7854
Angle	18° 11′	18° 11′
Addendum of teeth	0.250	0.250
Whole depth of teeth	0.539	0.539
Thickness of teeth	0.392	0.392
Outside diameter	20.50	5.50
Lead—exact	191.292	47.823
Lead—approximate*		
Cutter used	No. 2-4 p.	No. 5-4 p.
Hand	R. H.	L. H.

We first set down the assumed pitch diameters and figure the circumferences. From the number of teeth figure the circular pitch (see fourth place in the table), then assume a normal pitch and determine the angle. The tooth parts that follow are determined from the normal pitch. In case the angle is found too great, either the speed ratio or the center distance must be changed.

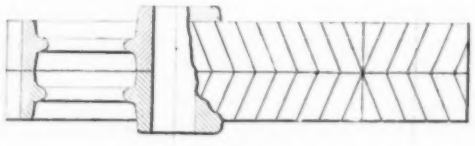


FIG. 7

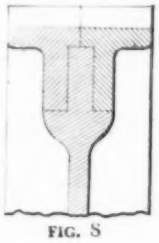


FIG. 8

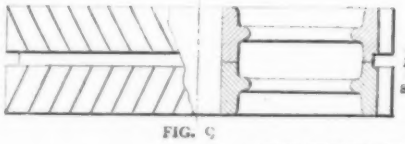


FIG. 9

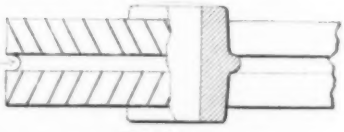


FIG. 10

THE DESIGN OF HERRINGBONE GEARS

On the other hand, suppose the center distance had not been fixed, and a velocity ratio of 4 to 1 was desired. We again arrange a table so that the items will come in rotation as they are assumed or calculated. In this case we assume the number of teeth to be 76 and 19, the spiral angle 15 degrees 0 minutes, and a 4-pitch cutter, 0.7854 inch normal pitch.

	Gear	Pinion
Number of teeth	76	19
Normal pitch	0.7854	0.7854
Angle of spiral	15° 0′	15° 0′
Circular pitch	0.8130	0.8130
Pitch diameter	19.668	4.917
Pitch circumference	61.788	15.447
Lead—exact	230.600	57.650
Lead—approximate		
Addendum	0.250	0.250
Whole depth	0.539	0.539
Thickness	0.392	0.392
Cutter used	No. 2-4 p.	No. 5-4 p.
Outside diameter	20.168	5.417
Hand	R. H.	L. H.

Gear on the worm.
First gear on the stud.
Second gear on the stud.
Gear on the screw.

Example: Suppose two spur gears of 60 and 15 teeth, three pitch, 12½ inches be-

*It is sometimes necessary to vary the lead a little, and the record should state the variation made.

tween centers, 4-inch face mounted on parallel shafts. It is desired to replace them with helical gears. The first point is to find a pair with fewer teeth, but of the same ratio, thus preserving the center distance. If, however, the same pitch tooth is inadmissible the number of teeth may be increased.

In the first instance we desire to use a three-pitch cutter; therefore, the number of teeth must be reduced and 56 and 14 are found to be in the same ratio as 60 and 15. By using the same pitch diameters the circular pitch will be found to be 1.122 inches. According to formula 3 the angle is found to be 21 degrees 2 minutes. While this angle might well have been less it is the best that can be had under the circumstances; unless, of course, the centers can be altered. On the other hand, had a finer pitch been decided on, say, a normal pitch of 0.7854 degrees (4-pitch cutter) we increase the number of teeth to 19 and 76, which gives a circular pitch of 0.8267 inch. The normal pitch is 0.7854, and the corresponding angle from formula 1 is,

$$Cosine\ E = \frac{0.7854}{0.8269} = 0.95004.$$

The angle whose cosine is 0.95004 = 18 degrees 11 minutes, the angle of the spiral. (This latter arrangement would probably be the better of the two.)

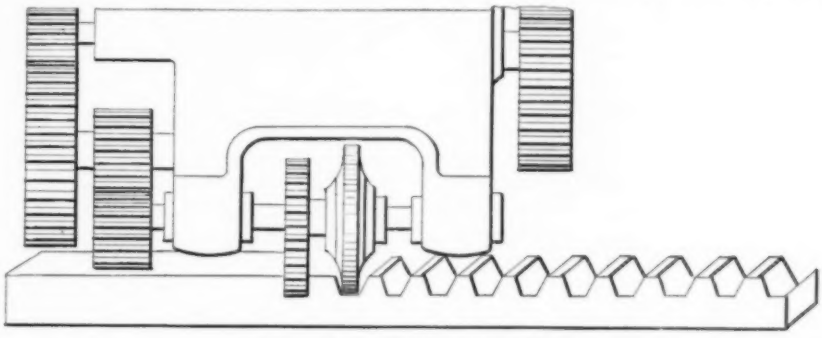


FIG. 11. A HEAVY GEAR DRIVE

Herringbone Gears

A double helical or herringbone gear, simply consists of two helical gears of right and left obliquity fastened together so as to form one gear. The object is to eliminate end thrust. See Fig. 7. The formulas for herringbone gears are the same as for helical, but the angle of the teeth may be made as acute as desired without fear of thrust; 30 degrees is common and even 45 degrees is often used; but, as stated under the head of helical gears, a shorter angle is more efficient as it gives a line contact approximating that of a spur gear.

This style of gear is extensively used for rotary blowers, air compressors, etc. They are, in fact, nearly indispensable for these and similar purposes, and it is believed the highest possible gear speed may be thus attained. Just what this speed is, is not definitely known. One authority puts it at one mile per minute. It is likely, however, that by using proper material in the gears this speed may be safely exceeded. One serious objection to this type of gear is the cost of manufacture. Doubtless but for this fact the use of herringbone gears would become almost universal. However, unless they are very accurately made and great care used in assembling them, they are little better than spur gears.

The most common design for herringbone gears is shown in Fig. 7. This is subject to many modifications in details, such as Fig. 8, where the rims are made separate from the spider to save cost and facilitate replacements. I think that it is an improvement to stagger the teeth in this type of gear, as shown in Fig. 9. Here, a space must be left between the teeth of each half where the halves join, for clearance. It has been claimed that in this design of gear (with the staggered teeth) the teeth tend to slide endwise on each other, alternately to the right and left, as the different sides of the gear engage. Stepped spur gears with a low number of teeth in the pinion might possibly do this, but it would be impossible with properly designed herringbone gears, because each tooth of a helical gear (half of a herringbone) remains in mesh until the next is well engaged. It is obvious that, with both sides of a herringbone gear thus engaged, alternate contact would be impossible.

A herringbone gear may be made in one piece by grooving between the faces to allow the cutter to run out, as shown in Fig. 10.

When the gear is made in this manner the pinion should be made in two pieces to facilitate the proper engagement of the teeth. It is extremely difficult to cut such gears interchangeably without special and unusual facilities. C. Wüst & Co., of Seebach Zurich, Switzerland, have designed a machine for cutting these gears. The cutter cuts across one face and runs into the space of a tooth on the opposite face. This reduces the space between the two gears to a minimum. The machine operates on both faces of the herringbone simultaneously. The inventors admit a loss of only 5 per cent. in efficiency in a gear reduction of 100 to 1; about the same loss as is generally accepted for a spur-gear drive making a reduction of 6 to 1. The claim is also made that these gears can be manufactured at an increase of but 25 per cent. over the cost of spur gears of the same general dimensions.

It will be noticed that helical and herringbone gears are greatly used on foreign machine tools; especially those of French make. The back gears of a lathe or milling machine seem peculiarly adapted to the use of helical gears because of the reduced thrust.

Fig. 11 illustrates the arrangement of gears on a heavy rack cutter. They were made helical after several discouraging experiments with ordinary spur gears. These gears were made of 20-point carbon-steel forgings and case-hardened. The machine is used in cutting as heavy as No. 1 diametral pitch, and on two-inch pitch it is used with two cutters, one for blocking and one for finishing, at a heavy feed. They have been in constant use for over two years and show little wear.

I hope that someone will perfect a machine for the commercial production of helical and herringbone gears.

Tests of Fiber Friction Washers

By S. P. Yeo

I have looked with considerable care for some definite information concerning the use of hard vulcanite fiber for friction purposes, especially for thrust disks. I have in mind several tests which we made with this material after phosphor-bronze disks failed. As these were extreme cases, I shall give details of them.

Our first experiment was on two disks 9 inches diameter with a 4-inch hole ⅜ inch thick. We used regular commercial red fiber, bored and turned carefully with cut oil grooves in it. The pressure these washers worked under was as follows: number of hours per day running, 9; revolutions per minute, 15; pressure per square inch, 350 pounds; disks running in oil.

We found upon examining these disks after one month's service that the fiber had worn to a glazy surface and showed very little wear; the action of the oil upon it appeared to give a glossy surface. The life of such a pair of disks was 1½ years; the same size in bronze lasted about three months.

Since the above test we have abandoned the use of metallic disks and used the fiber exclusively. The cost is much less; and as stated above, the fiber lasts much longer, especially where the machinery is in the hands of incompetent operators.

The same grade of fiber was used with success by us for the steps of grinders. The conditions of those tests were less severe than those of the one before stated. As there is little information to be had concerning this matter, I should be glad to have the views of other users of vulcanite fiber.

The Fly Cutter as a Reference Gage

Supplementing the Article on the Fly Cutter in Punch and Die Work and Showing Additional Novel Uses of the Fly Cutter

EDITORIAL CORRESPONDENCE

On page 109 was published an article describing the methods used by the Morse Chain Company in originating complex outlines by the use of elementary fly cutters, and in this article additional examples of that class of work will be given, with further particulars showing how cutters of this kind are used as ultimate standards on which the high-speed chain industry is largely based.

The Requirements to Be Met

Fig. 1 shows three links of a Morse chain from which the requirements which have to be met can be readily understood. The work to be described is the punching of the holes in the ends of the links which must be done to a high degree of accuracy. The punching of these holes is, in fact, a much sharper test of the methods than the punching of the link blanks, and this largely because the holes are so small. In the smallest size of chain the width of the seat pin across the flat, which, roughly, is the diameter of the holes to be punched, is but two-tenths of an inch, and the outlines shown must be made to these small sizes and with a degree of accuracy which is high.

Referring to Fig. 1, the hole at *a* shows the outline required for the seat-pin hole, the seat pin being shown in position. The left-hand side of the hole, which forms the seat for the pin, must be an accurate fit with the pin. The right-hand side is only required to clear the rocker pin, as shown at *d*, and for this the accuracy required is, of course, much less. Similarly, the right-hand side of the hole *b* is a seat for the rocker pin, while the left-hand side is only required to clear the seat pin as shown at *c*, and here again one side of the hole must be of a high degree of accuracy, while the other may be less accurate. The joints shown at *c* and *d* are complete with both pins in position.

To show the amount and kind of work involved, Fig. 2 is included, in which the measurements required by the toolmaker for a pair of holes are given. A glance at this illustration, remembering that these holes are made down to diameters of about 3/16 inch, will emphasize better than any description in words the problem which is involved in making the punches and dies for them.

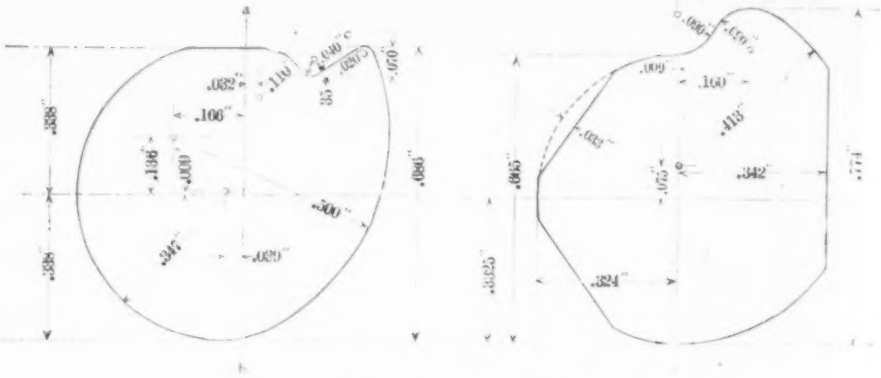


FIG. 2. DETAILED OUTLINES OF THE WORK

It will be seen that the outlines of these holes are made up, like those of the link blanks, of straight lines and circular arcs, and these in the end go back to simple elementary cutters, made precisely as are those described in the previous article, making it unnecessary to repeat a description of this part of the work. It should, however, be mentioned that whereas for the link blanks these methods are employed for making the punch only, the die being made by using the punch as a broach, in the present case they are employed for making both the punch and the die. To make the dies by these methods it is necessary to make them in halves, and this is done as shown in Fig. 3, which includes a set of punches and dies together with a sample of the work which they do. The dies are slightly separated in order to show how they are parted.

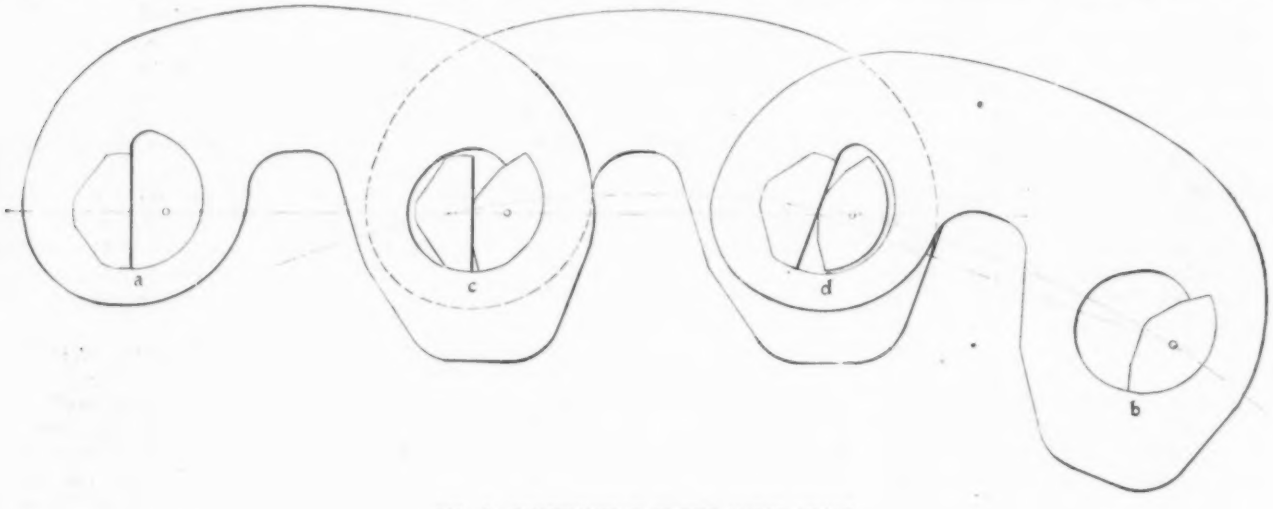


FIG. 1. CONSTRUCTION OF THE MORSE CHAIN

The Cutter as a Reference Gage

Referring to Fig. 4, there is shown at *a* a male fly cutter, of which the

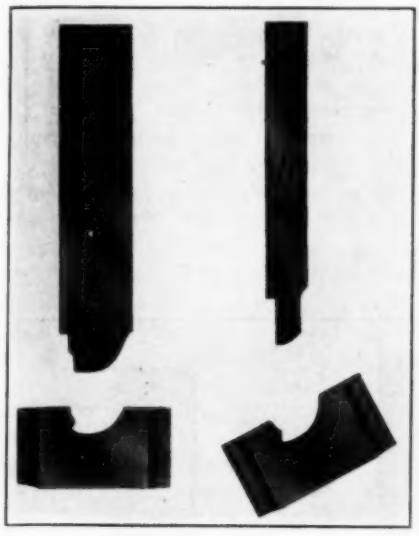


FIG. 6. MAKING AN UNDERCUT

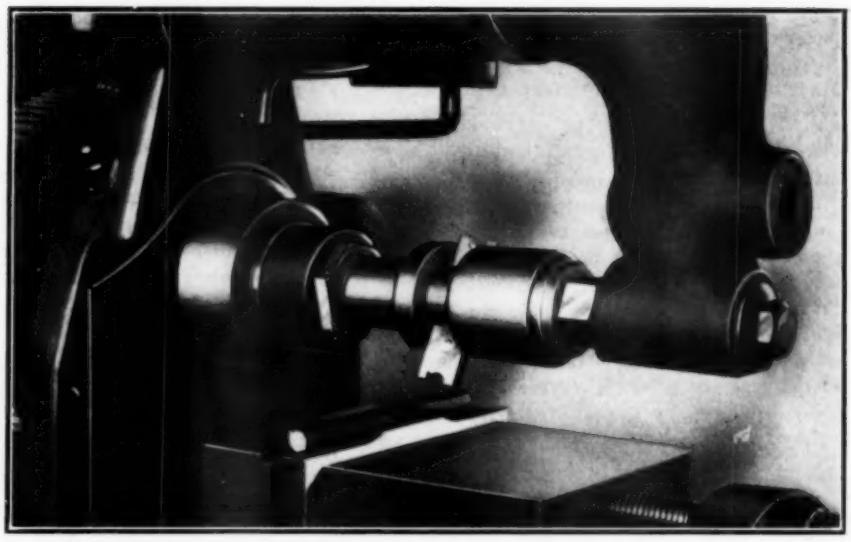


FIG. 7. MAKING RIGHT- AND LEFT-HAND PUNCHES

outline is that of the left-hand side of the hole *a*, Fig. 1. This cutter is made by the methods described in the previous article, and it forms the ultimate standard of reference for the chain of the appropriate size. With this cutter a second female cutter, shown at *b*, is made, and also a gage shown at *c*. With the female cutter a milled sample *d* of the seat-pin stock is made. The milled sample and its gage are supplied to the wire mill, where the drawn stock is made, and supply the working standards for this wire. The milled sample is, of course, a fit in the gage, and in addition to this, the back of the milled sample and the bottom of the gage are ground to such dimensions that when the sample is inserted in the gage the overall measurement from the bottom of the gage to the back of the sample will be a defined distance, which is stamped on the gage and the drawn wire, when inserted in the gage, must show this dimension by a micrometer.

Cutter *a*, Fig. 4 is used for making cutter *b* and gage *c* and for nothing else. Cutter *b* is used for making the milled sample *d* and the working cutters as described in the next paragraph and for nothing else. The life of cutter *b* is thus a long one, especially as, from the manner of its making, it may be sharpened by grinding without changing its form. Considering this long life of *b* it will be seen that the life of *a* is prac-

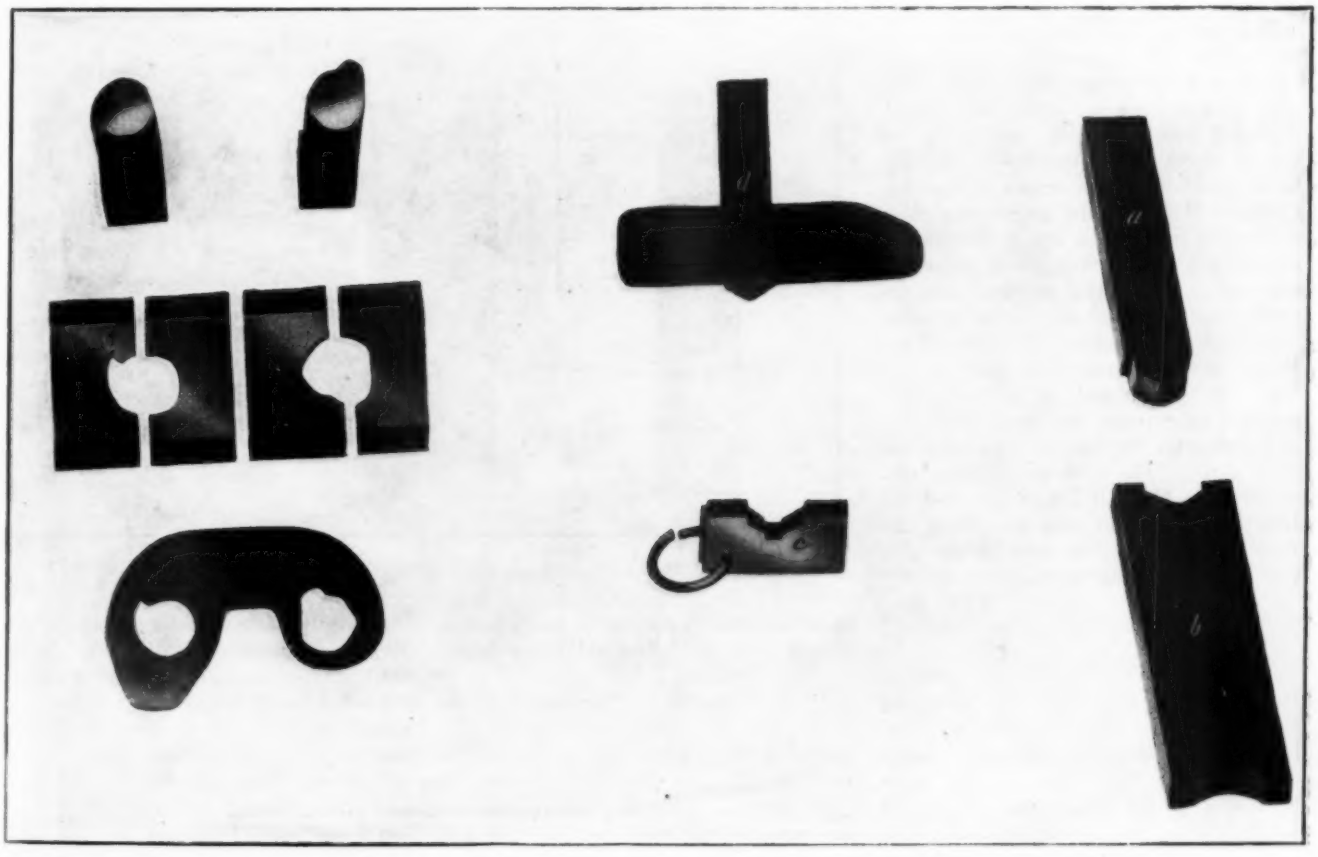


FIG. 3. PUNCHES, DIES AND A SAMPLE OF WORK.

FIG. 4. REFERENCE CUTTERS AND GAGES

tically infinite and it thus becomes a satisfactory basic standard.

Making the Working Cutters and the Punches

Referring now to Fig. 5, cutter *c* is made from *b* of Fig. 4 and from *c a* Fig. 5 is made in turn. Obviously *c* produces one half the die as shown below it while *a* produces one side of the punch *b* above it. Similarly at *d* and *e* are cutters for the opposite sides of punch and die respectively. The cutters and other tools shown in Figs. 4 and 5 obviously relate to the seat pin hole, the rocker pin hole being produced by similar methods.

Making the Dies

The die for the rocker pin end of the links, shown at the left in Fig. 2, is parted on the line *a b*, and this it will be seen involves an undercut at *c*. The making of this undercut involves a second operation in milling the die for this outline, the complete method of making the die being shown in Fig. 6. At *a* and *b* are shown the working cutters, the operation of milling the die being obvious from the arrangement of the cutter *a* and half of the die. This cut completed, the die is mounted in the milling machine at an angle, as shown at *c*, and a second cutter shown immediately above it, completes the undercut.

Right- and Left-hand Punches

In order to insure that the chain shall be straight when completed, it is found necessary to punch one-half of the links with a right- and the other half with a left-hand punch and die, and it is, of course, essential that the right- and left-hand tools be exact duplicates in their dimensions. The method of securing their duplication is shown in Fig. 7. The square blank for a pair of punches is shown as mounted in the milling machine, and the cutter producing one side of the punches is also shown in position. It is obviously a simple matter to mill both ends of the blank to shape, and to complete the punches by turning the blank half over and then mill the second side with another cutter. The form completed in this manner, the blank is cut in half and the result is a pair of punches which obviously are exact duplicates except that they are of opposite hands.

F. A. H.

Many different mixtures are used in Italy at the present time for soldering preparations, but they are nearly all primitive. There are some patented articles on the market, but they do not seem promising, as the Italian user in general would rather use a mixture containing muriatic acid, which he has always used, than risk novelties.

American Machinery and Tools in Australia

By F. C. Chappell

A short time ago a Melbourne firm of long standing made an interesting and valuable report to the Chamber of Commerce of that city, dealing with the machinery trade of the Commonwealth. This firm of importers stated that where-

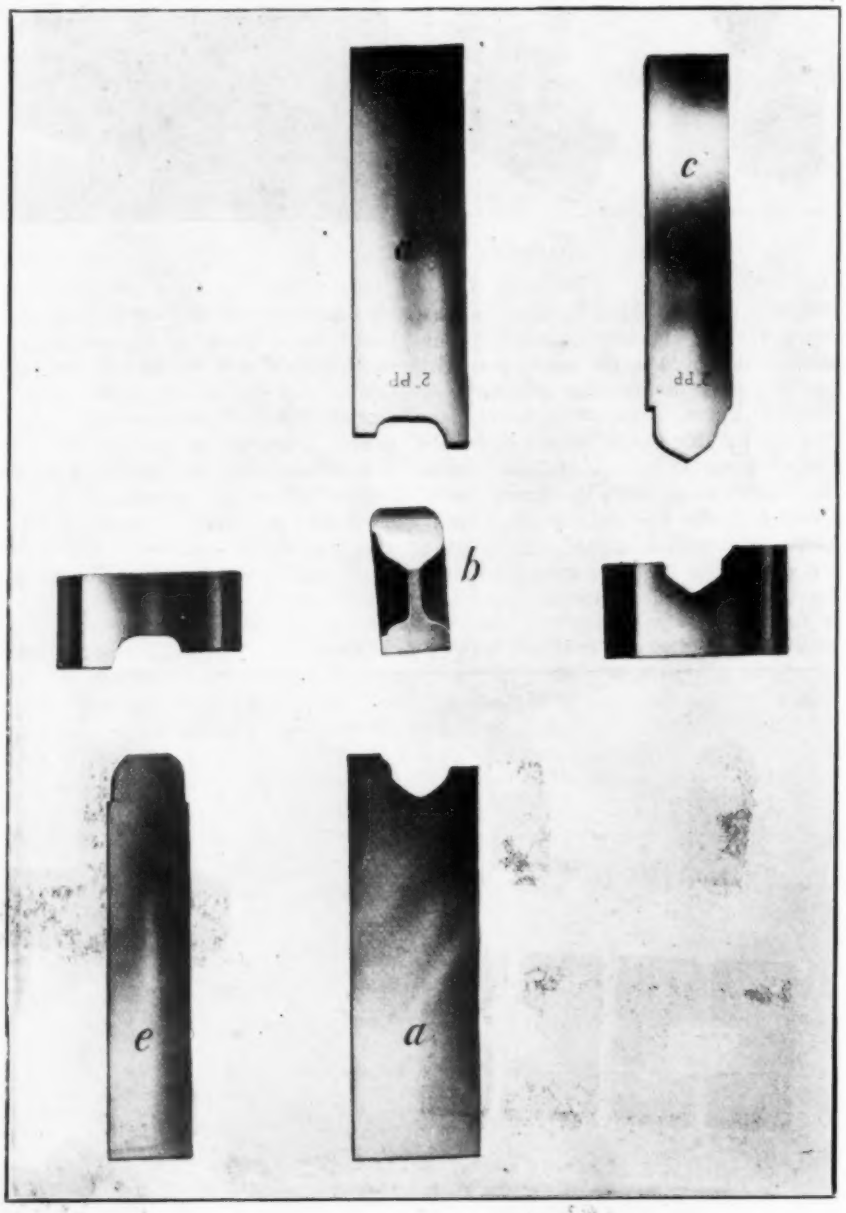


FIG. 5. WORKING CUTTERS PUNCH AND DIE

as ten years ago the whole of their machinery came from England, today America and Germany supply from 60 to 70 per cent. of the total. The writers of the report are merchants catering for the wants of the engineering trade, and as such they keep an all-round selection. In some machine tools the American make has entirely displaced the English, and now the Germans are sending machines that in some respects have advantages over both English and American. Within the last few years the British manufacturer has endeavored to bring his machines up to date. Formerly no amount of correspondence would make him alter his views, and often he would maintain that people buying machines made outside of Great Britain were not getting the best and did not know what they wanted.

As regards rolled shafting, American makers have secured this market, and most Australian buyers have to pass over English manufacturers for the better finished and cheaper article. American exporters send bright steel turned and packed in boxes, as is done by English makers. American firms have quoted £9 10s. per ton delivered in Australia and New Zealand, whereas British firms could not quote less than £11 15s. f.o.b. Liverpool. The great difference in price is ascribed to dumping surplus stock,

though it may also be due to some extent to cheaper freights from the United States. Samples of German shafting have also been put upon the Australian market, which bear favorable comparison with both American and English in price and finish, but so far there appears to be no serious competition from Germany.

With reference to steel plates and bar iron, the opinions held by different importers in Australia with regard to the quality of American made plates and bars are somewhat conflicting; but there seems to be a general feeling that if British manufacturers could keep their prices down to the level of their competitors, the trade would go to them in preference to others. Americans are said to have lost a considerable portion of this trade owing to the erratic nature of their quotations, to the uncertainty which marks the delivery of their goods and also to the fact that in many instances the quality of the bar iron supplied was so uneven that orders were not repeated.

American makers are supplying galvanized sheets at £2 per ton less than British quotations. Several Australian houses have ordered the American sheets, and no difficulty has been found in selling them.

With regard to tools, here American competition has been particularly successful. The gains of the United States manufacturers are generally attributable to the disinclination of British manufacturers to adapt their goods to the Australian market. Thus one importing firm states that it had repeatedly given British manufacturers samples of tools wanted, but the reply had invariably been: "We don't make that kind; this is what we have." The trade has consequently gone to the United States and Germany, whose manufacturers will make anything that is required. British makers are, however, beginning to alter these tactics and are sometimes showing themselves more accommodating to the wishes of their customers. In some instances they appear to be recovering part of their lost trade.

It is asserted that in certain cases some American tools owe their success not so much to prices as to attractive appearance. In some instances, also, American tools suitable to Australian conditions are protected by United States patents.

As regards files, America undoubtedly holds the market. Its makers supply a light machine-cut file, which, of course, is cheaper than the heavier English files; as files are not re-cut in Australia, but thrown aside when worn out, they suit their purposes as well as the heavier ones. It is not contended that they are better than the average English makes, and it is thought that many buyers would choose the English file if sold at the same price. The American method of packing in cardboard boxes is well worth imitation by English makers.

As regards twist drills, this trade was formerly in the hands of American makers, but latterly British firms have been competing for the business with special high-speed drills.

Firmer and socket chisels are generally supplied by British makers, although formerly a good deal of this business was done from the United States. Hand bolt cutters for cutting bars and bolts are chiefly supplied from America. A good many braces supplied to the Australian market are of American manufacture, but a Scotch firm has commenced to make an imitation of one of the best American patterns, and has competed successfully ever since. Anvils and axes are nearly all of American manufacture, while the same may be said regarding saws, iron planes, some lines of shovels, claw hammers, etc. Mowing machines, reapers and binders are almost entirely supplied by American makers, also plows with iron beam; single and double furrow plows are chiefly of the same origin. They are cheap and good and in great demand.

Newall Standard Limits for Fits in Metric Dimensions

By J. E. Story*

The accompanying table gives allowances for various classes of fits in metric dimensions. It practically amounts to the transposition of the Newall standard limits from English sizes to the metric. The system applied to English dimensions has been published in the American Machinist and the metric tables may be of interest to many of the readers, particularly to those who are unfortunate enough to have to work to the metric system.

TOLERANCES IN STANDARD HOLES.
(2 Grades)

	Nominal Diameters.	Up to 15	16 to 25	26 to 50	51 to 75	76 to 100	101 to 125	126 to 150
CLASS A	High Limit..	+ 0.007	+ 0.013	+ 0.019	+ 0.026	+ 0.026	+ 0.026	+ 0.039
	Low Limit ..	— 0.007	— 0.007	— 0.007	— 0.013	— 0.013	— 0.013	— 0.013
	Tolerance...	0.014	0.020	0.026	0.039	0.039	0.039	0.052
CLASS B	High Limit..	+ 0.013	+ 0.019	+ 0.026	+ 0.032	+ 0.039	+ 0.045	+ 0.051
	Low Limit ..	— 0 013	— 0.013	— 0.013	— 0 019	— 0.019	— 0.019	— 0.026
	Tolerance...	0.026	0.032	0.039	0 051	0.058	0.064	0.077

ALLOWANCES FOR VARIOUS FITS.

FORCE FITS

	Nominal Diameters.	Up to 15	16 to 25	26 to 50	51 to 75	76 to 100	101 to 125	126 to 150
CLASS F	High Limit..	+ 0.026	+ 0.051	+ 0.102	+ 0.153	+ 0.204	+ 0.255	+ 0.306
	Low Limit ..	+ 0.013	+ 0.038	+ 0.077	+ 0.115	+ 0.152	+ 0.203	+ 0.254
	Tolerance...	0.013	0.013	0.025	0.038	0.052	0.052	0.052

DRIVING FITS

	Nominal Diameters.	Up to 15	16 to 25	26 to 50	51 to 75	76 to 100	101 to 125	126 to 150
CLASS D	High Limit..	+ 0.013	+ 0.026	+ 0.039	+ 0.064	+ 0.077	+ 0.089	+ 0.102
	Low Limit ..	+ 0.007	+ 0.019	+ 0.026	+ 0.039	+ 0.051	+ 0.063	+ 0.076
	Tolerance...	0.006	0.007	0.013	0.025	0.026	0.026	0.026

PUSH FITS

	Nominal Diameters.	Up to 15	16 to 25	26 to 50	51 to 75	76 to 100	101 to 125	126 to 150
CLASS P	High Limit..	— 0.006	— 0.006	— 0.006	— 0.012	— 0.012	— 0.012	— 0.012
	Low Limit ..	— 0.019	— 0.019	— 0.019	— 0.026	— 0.026	— 0.026	— 0.026
	Tolerance...	0.013	0.013	0.013	0.014	0.014	0.014	0.014

RUNNING FITS (3 Grades)

	Nominal Diameters.	Up to 15	16 to 25	26 to 50	51 to 75	76 to 100	101 to 125	126 to 150
CLASS X	High Limit..	— 0.025	— 0.032	— 0.045	— 0.051	— 0.063	— 0.076	— 0.089
	Low Limit ..	— 0.051	— 0.070	— 0.090	— 0.108	— 0.127	— 0.146	— 0.165
	Tolerance...	0 026	0.038	0.045	0.057	0.064	0.070	0.076
CLASS Y	High Limit..	— 0.019	— 0.025	— 0.032	— 0.038	— 0.051	— 0.057	— 0.063
	Low Limit ..	— 0.032	— 0.051	— 0.064	— 0.076	— 0.089	— 0.101	— 0.114
	Tolerance...	0.013	0.026	0.032	0.038	0.038	0.044	0.051
CLASS Z	High Limit..	— 0.012	— 0.019	— 0.019	— 0.025	— 0.025	— 0.032	— 0.032
	Low Limit ..	— 0.019	— 0.032	— 0.039	— 0.051	— 0.057	— 0.064	— 0.070
	Tolerance...	0.007	0.013	0.020	0 026	0.032	0.032	0.038

THE NEWALL STANDARD
TABLES OF ALLOWANCES FOR VARIOUS CLASSES OF FITS IN MILLIMETERS

*General manager, the Newall Engineering Company, Ltd., Warrington, England.

Molding a Screw Propeller in Loam

A Large Job Which Was Done in Spite of Cheap Equipment—A Novel Style of Cope—How Its Skeleton Was Framed

BY JOSEPH F. HART

The steamer was in drydock and the old propeller was showing signs of its approaching end, so it was decided to have a spare one made. The foundry agreed to deliver the casting in nine days, using the old wheel (which was to be re-hung on the steamer) as a pattern. The wheel was 16 feet 8 inches in diameter and the hub about 4 feet in length.

The Bottom Plates and Seat for the Mold

To start the job a hole sufficiently large was dug in the foundry floor between two cranes; this hole was about 3 feet deep and was shaped like a cross with arms 10 feet long and a large center. The bottom of this pit was leveled up and four bottom plates, Figs. 3 and 4, were laid down in the proper positions. The old screw, partially shown in Figs. 1 and 2, was then blocked up level on these plates with one bearing under each blade, as shown at *A*, Fig. 3; the mold was started by bricking up under the hub, making a tapered joint down to the edge of the hole left where the four bottom plates came together at the center and putting parting material on this joint. This seat or bearing is shown in partial section at Fig. 4; it rests on the bottom of the pit and is dried there with fire baskets after the rest of the mold has been lifted away.

After this seat was finished, the under side of each blade was bricked up, loam being used on the bricks next to the pattern and mud on the outside course, the large space between being filled in with broken brick and the interstices filled with dry dust from the foundry floor. Fig. 5 gives a vague idea of a section of this brickwork, *X O* being the bearing for the cope. The upper member of the cope being cast on a flat bed, it was necessary for the bearing to slant downward in a straight line as to its elevation, but, in plan, following the curve *Y Y*, Fig. 2. The dotted lines in Fig. 1 give an idea of the relation of the shape of this bearing to that of the elevation of the blade, the bearing being trued up to suit the shape of the copes as each one was assembled in place.

The Cope

The copes themselves were tidy and cheap pieces of rigging as far as they went, each one composed of five pieces shown in detail in Figs. 6 to 10, and being composed of the following parts: Lower plate, Fig. 6, with prickers, two lifting lugs and three upright lugs cast on; upper plate, Fig. 7, with two lifting lugs and three lugs to correspond with Fig. 6 when in position. Fig. 8 is an end piece with prickers cast on to carry the sand around the hub and with holes for the gas to get away. Figs. 9 and 10 are two cross-bars to hold the affair together, though Fig. 9 helps to carry the brick-work.

The Job Done With Indifferent Facilities

There being no pattern or carpenter shop connected with the foundry, the foreman himself made wooden templets for these shapes out of some old packing cases. They were then outlined on an

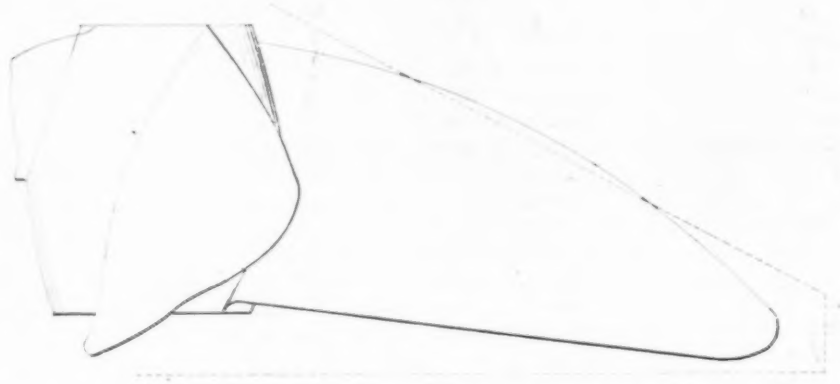


FIG. 1. PARTIAL ELEVATION OF THE PROPELLER IN THE POSITION IN WHICH IT WAS CAST

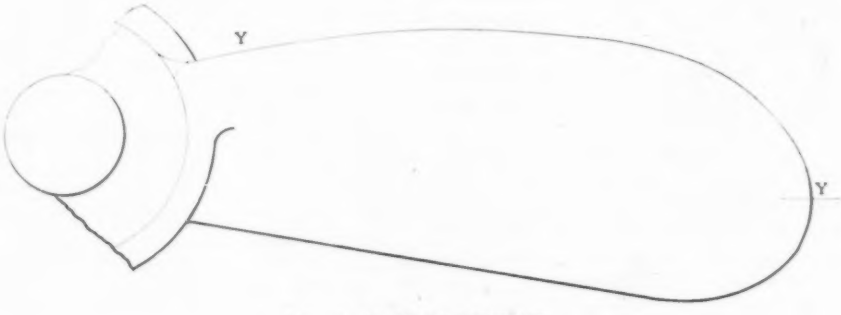


FIG. 2. BLADE OF PROPELLER

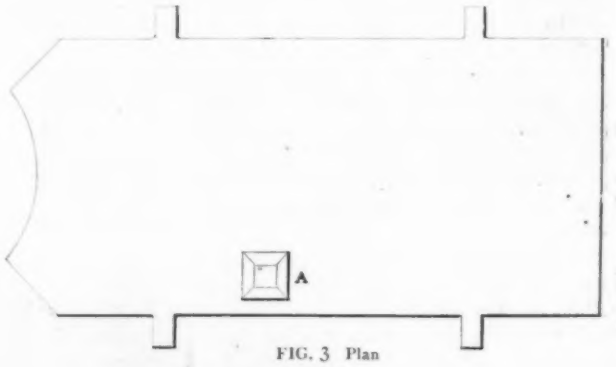


FIG. 3 Plan

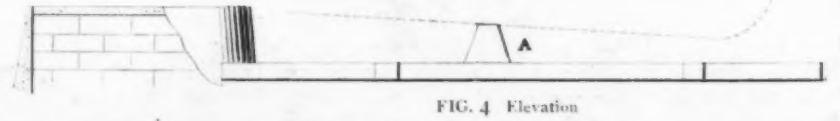


FIG. 4 Elevation

PLATE FOR BOTTOM OF PIT

open sand bed and the molds made up with the use of such material as could be found about the shop, which really amounted to a few brick and some pieces of wood brought to the foundry originally to use for fire-wood.

The total molding cost of the four copes was about $4 (that much was good work); assembling them, however, cost considerable, though this was due to the wretched crane facilities.

The Operation After Framing the Cope

As soon as one cope skeleton was bolted together and the parting finished to suit it, two men proceeded to lay the brick in it, care being necessary, as there was not much to support the brick-work, especially at the wider, flatter part of the blade, which was fully 4 feet across; the arch, if there really was any, was practically nil. That portion of each cope which formed the hub was rammed up with dry-sand facing, properly gaggered, etc. After all the copes were bricked up and properly marked, they were hoisted off, blocked up on the foundry floor, finished and blackened.

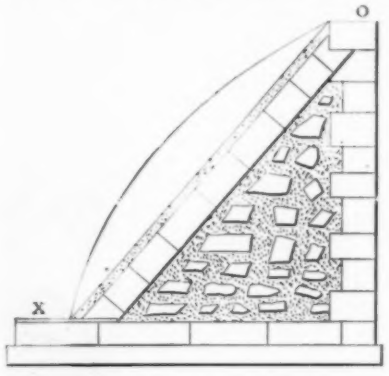


FIG. 5. SECTION OF BRICKWORK

Drawing the Pattern and Drying the Blade Molds

The pattern was then drawn (this one weighed within a few pounds of nine tons), the bottom half of each blade mold finished, and after the bottom blades were staked to insure their return to a proper position, each section was lifted on to the drying carriage and the copes placed on them, each cope, however, being blocked up a few inches; the whole was run into the oven and left there until dry.

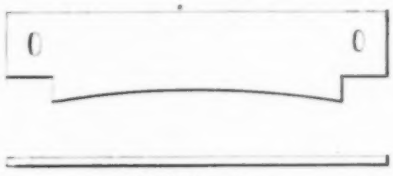


FIG. 9. Cross-Bar

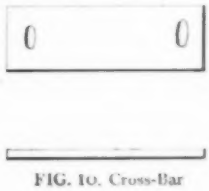


FIG. 10. Cross-Bar

PIECES USED IN FRAMING THE SKELETON OF THE COPE

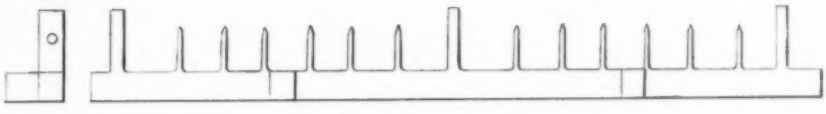


FIG. 6. LOWER COPE PLATE

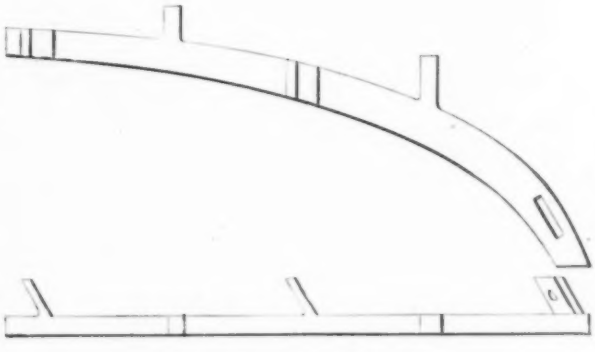


FIG. 7. UPPER COPE PLATE

Replacing the Molds in the Pit

When the carriage was hauled out again, a complete blade mold was placed in the pit at each lift; the copes one at a time were then raised enough to remove the blocking and brush out any dust which had gathered. They were then put together accurately by the matching of the marks mentioned before, and the joints at the hub made up neatly.

The center core was then set and the hub covered with a cake core in which were five holes for pouring gates, each 1½ inches in diameter, and one about 4 inches for a riser.

Binding the animal together was sort of a nightmare of a job, and I guess no two of the blades were fastened alike; but it went something like this:

First we got a soul-and-body hitch* under the four bottom plates in the center, bringing the loose ends up between the arms in a position to be secured later on.

How the Copes Were Kept Down

The blade copes, though a very good rig for carrying brick-work, had absolutely no strength to withstand the upward pressure of liquid iron; to overcome this lack, a number of plates generally used for drying cores were used as follows: A bed of soft sand was spread over the brick-work and the plates were rubbed on this bed until a firm, even bearing was secured all over the bricks. Then four straight-barred iron copes (part of the general shop equipment), 8 to 10 feet long and 4 to 6 feet wide, were placed, one over each blade, but blocked up in such a manner that they were just clear of the plates mentioned. These copes were then clamped to the bottom plates; the loose ends of the bottom hitch were then hooked to the arms of a binding cross and a strain put on them with the crane.

The inner ends of the binding copes and the hub covering core were then wedged from the cross; and all the plates covering the brick-work were then wedged down from the bars of the binding copes, the general idea being to put on a clamp or drive in a wedge wherever there was a chance to put one.

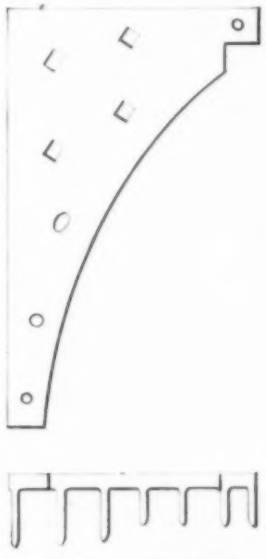


FIG. 8. END PIECE FOR COPE

*We presume this means a strong one, though soul and body sometimes separate quite readily.—Ed.

Finishing and Pouring

The whole thing was then rammed up with sand, in, between and around and over, the runner built for two ladles and the job cast at half-past ten at night; a 6-ton and a 3-ton ladle were used, and there was hardly enough iron, although the mold was really filled.

The Wastefulness of Poor Equipment

The shop was old-fashioned, with poor equipment, and had two majestic jib cranes, requiring a small army of laborers to move them. Speed could not be gotten out of them at any price. Add to this the policy of furnishing practically nothing for the molders to work with, and we find that the amount of labor going into a job would appal the owner of a better-equipped foundry, this propeller footing up at the rate of a few over 50 days for one molder and a laborer, although cast on the night of the seventh day by working several men overtime.

A modern shop with reasonable equipment could produce the same casting with one-third the amount of labor. Take the one item of placing the mold in the pit and preparing it for the metal, in this case involving a direct expense of about $60, and compare it with the case of a similar wheel 15 feet in diameter and weighing over 8 tons, which was made in another shop, and taken from the oven and made ready for casting at a cost of $16 and no need of hurry.

A Suggested Improvement

I mentioned that the copes used were tidy and cheap rigging; one of these copes

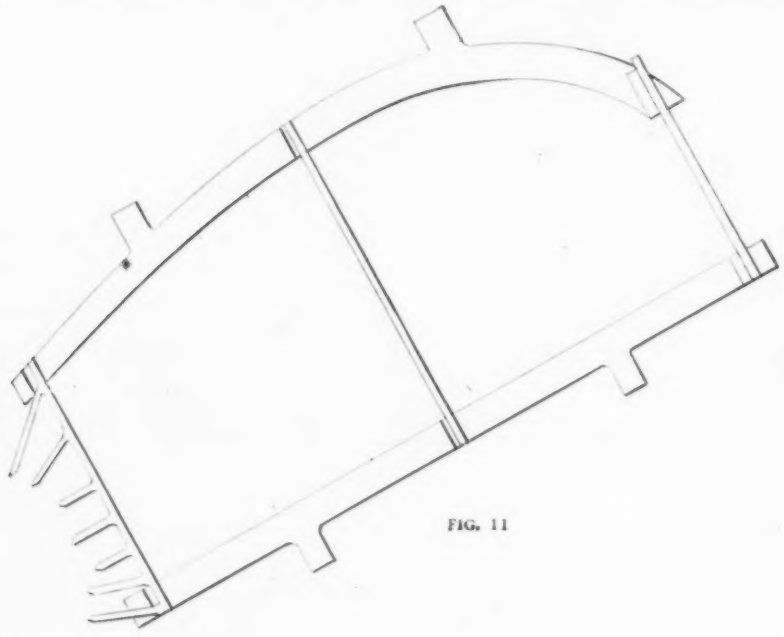


FIG. 11

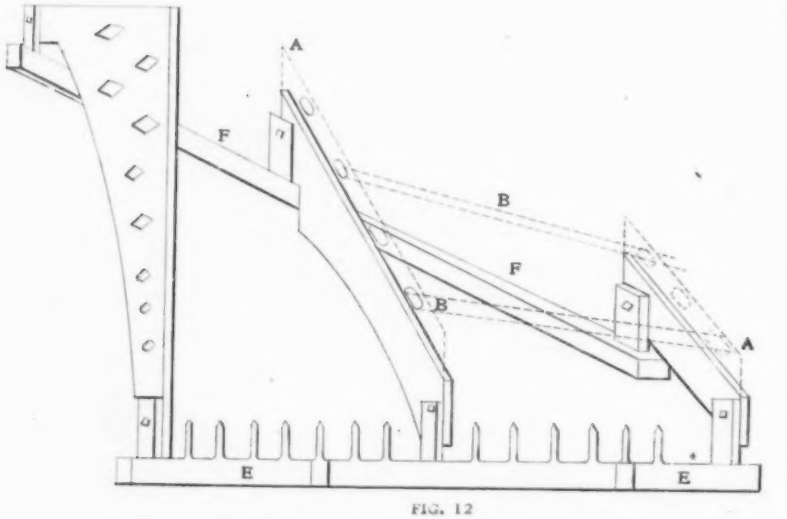


FIG. 12

ASSEMBLED COPE SKELETON

is shown assembled in Figs. 11 and 12. The dotted additions at *A A*, Fig. 12, show how by making the cross bars, Figs. 9 and 10, a few inches wider, casting a few 2-inch holes in each, and passing two or more pieces of bar iron through them, as at *B B*, the plates covering the brickwork could be wedged from these bars. Then by clamping the lower and upper plates *E E* and *F F* to the bottom plates, the binding copes could be dispensed with (the price of a couple of new hats saved—girls' hats at that), making each blade practically the same as if made in a flask, as smaller wheels are made in so many places.

The Solution of Bevel-geared Epicyclic Trains

By W. Owen

In my first article on epicyclic gearing I gave the following rule:

$$\frac{n-l}{a-l} = \pm \textit{ value of velocity ratio of train,}$$

where n = revolutions of last wheel, a = revolutions of first wheel, l = revolutions of arm. The sign for the value of the train is determined upon by inspection, thus:

If the arm be held and the first wheel revolved, if the last wheel revolves in the same direction as the first wheel, the sign is +; if in the opposite, —.

The Question of Direction of Motion in the Bevel Gears

As some difficulty may be encountered in the application of this rule to bevel-geared epicyclics, owing to the altered position of the revolving arm and wheels from ordinary spur-geared epicyclics, I propose to show how this difficulty may be overcome, and to work out, by this rule, a rather intricate mechanism.

The difficulty aforementioned will be apparent from the following:

Referring to Fig. 1, *A* is a loose wheel mounted on stud *B*. *C* is keyed to the shaft *D*. Supposing that it were necessary to calculate the revolutions of *A*, knowing the revolutions of the stud and of the wheel *C*, what sign must we prefix to the quantity for the value of the train, or $\frac{C}{A}$? That is, if *B* be held, and *C* revolved, are *A's* revolutions in the same or opposite direction to *C's*? I don't know. Again, supposing that *A* be rotated once on its own axis, and then *B* rotated on the axis of *D*, how many revolutions has *A* made now? I don't know that either, and what's more I don't care, for this reason: The mechanism as shown could not be called an epicyclic train, as the motion must terminate in a plane parallel to the one in which it commenced, so that I am only concerned with the results of *A's* motion, not with its actual motion, and if I can show a method of obtaining these results, my purpose will have been served.

Finding the Velocity Ratio of a Miter-gear Train

Referring now to Fig. 2, *A*, *B* and *C*, are three miter wheels. *A* is fixed, *B* is loose on stud *E*, which is free to revolve on *D*. *C* is keyed to *D*.

In this instance we will calculate the revolutions of the arm per revolution of C, with A fixed or stationary.

To obtain the sign for the value of the train, it is clear that if E be held and C revolved, A would revolve in the opposite direction to C, therefore the sign is —. Applying the rule, we get:

$$\frac{n-l}{a-l}=-\frac{C}{A};\ \frac{0-l}{1-l}=-\frac{1}{1},$$

$$0-l=-1+l,\ -2l=-1,\ l=\tfrac{1}{2}.$$

Therefore for one revolution of C with A stationary, the arm will make one-half a revolution in the same direction.

The Step-by-step Method of Analysis

Now suppose that instead of working the whole thing out at once, we treat it in steps, thus: Ignore A for the present and calculate the revolutions of B due to one revolution of C and one-half revolution of the arm E in the same direction. Now in this case, we will prefix the value of the train $\frac{C}{B}$ by the + sign.

Thus we get:

$$\frac{n-\frac{1}{2}}{1-\frac{1}{2}}=\frac{1}{1};\ n-\tfrac{1}{2}=1-\tfrac{1}{2};\ n=1.$$

Thus for one revolution of C and one-half a revolution of the arm E in the same direction, B will make one revolution in the same direction as C.

Now ignore C and calculate the revolutions of A due to one revolution of B and one-half revolution of E in the same direction. If our method is correct, this of course should $= 0$, as previously it

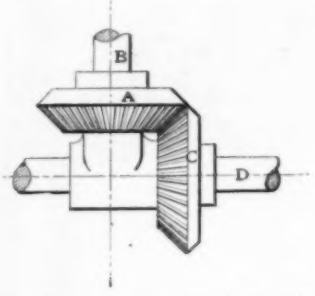


FIG. 1. ILLUSTRATING THE QUESTION OF RELATIVE DIRECTION OF ROTATION IN BEVEL GEARS

has been stated that A is a fixed wheel.

Now in this case we will prefix the value of the train, or $\frac{B}{A}$ by the — sign.

Thus we get:

$$\frac{n-\frac{1}{2}}{1-\frac{1}{2}}=-\frac{1}{1},\ n-\tfrac{1}{2}=-1+\tfrac{1}{2},$$

$$n=0.$$

Thus it will be seen that when dealing with a bevel-geared epicyclic in steps, the value of the train for the first pair of gears must be +, and for the second pair —, or *vice versa*. In the first step, had we taken $\frac{C}{B}$ as $-\frac{C}{B}$, we should have obtained a different result for the revolutions of B; but we should have obtained the same final answer by taking $\frac{B}{A}$ in the second step instead of $-\frac{B}{A}$.

The whole thing will be seen at a glance to be mathematically correct, as the full value of the train being minus, the algebraic product of the signs taken in the two steps must also be minus.

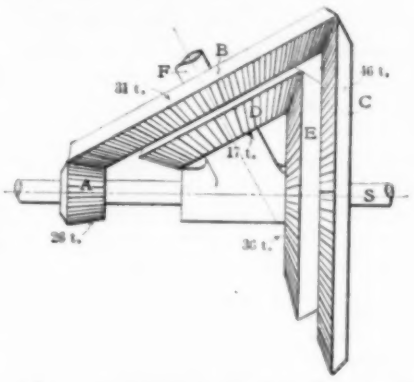


FIG. 3. A COMPOUND BEVEL-GEARED EPICYCLIC TRAIN

Finding the Velocity Ratio of a Compound Bevel-geared Epicyclic Train

A very instructive and interesting example of a bevel-geared epicyclic which embodies all these little intricacies is shown in Fig. 3. The mechanism as illustrated is used in Humpage's patent lathe, being mounted on the spindle inside the cone.

A is a pinion of 26 teeth keyed to the cone pulley; B and D have respectively 31 and 17 teeth, and are keyed together but revolve loosely on stud F, this stud also being free to revolve about the spindle S. C is a stationary wheel of 46 teeth, and E is keyed to the spindle and has 36 teeth.

When A is driven by the cone, B will rotate on its own axis, and, as C is a fixed wheel, the motion of B must cause stud F to revolve around the axis of S, carrying B and D with it and causing D to drive E.

I will now show how to find the number of revolutions for one revolution of A.

First Step—Velocity Ratio of A and F

Dealing in the first place with wheels A, B and C, we will find the revolutions of the stud F due to one revolution of A, with C fixed.

$$\frac{n-l}{a-l}=-\frac{26}{46},\ \frac{0-l}{1-l}=-\frac{26}{46},$$

$$46l=26-26l,\quad 72l=26,$$

$$l=\tfrac{26}{72}\text{ or }\tfrac{13}{36}.$$

Therefore the arm or stud F makes 13/36 revolution in the same direction as A, per revolution of A.

Second Step—The Angular Velocity of B

Now dealing only with A and B and the arm, we require to find the revolutions of B due to one revolution of A and 13/36 revolution of the arm F in the same direction.

Now in this step we will take the sign for the value of the train, or $\frac{A}{B}$ as —.

$$\frac{n-l}{a-l}=-\frac{A}{B},\ \frac{n-\frac{13}{36}}{1-\frac{13}{36}}=-\frac{26}{31},$$

$$31n-(31\times\tfrac{13}{36})=-26+(26\times\tfrac{13}{36}).$$

Working this out, $n=-\frac{65}{372}$.

So far we have that for one revolution of A the arm makes 13/36 revolution in the same direction as A, and B makes $\frac{65}{372}$ revolution in the opposite direction to A.

Third Step—The Angular Velocity of E

But D, being keyed to B, must have exactly the same motion as B; therefore now we require to find the revolutions of E due to 13/36 revolution of the arm F and $\frac{65}{372}$ revolution of D in the opposite direction.

When dealing separately, in the second step, with A and B, we prefixed $\frac{A}{B}$ by —; therefore, in dealing now with D and E, $\frac{D}{E}$ must be $+\frac{D}{E}$.

$$\frac{n-l}{a-l}=\frac{D}{E},\ \frac{n-\frac{13}{36}}{-\frac{65}{372}-\frac{13}{36}}=\frac{17}{36},$$

$$36n=(36\times\tfrac{13}{36})-(17\times\tfrac{65}{372})-(17\times\tfrac{13}{36}).$$

Working this out, $n=0.108$. Therefore for one revolution of A, E will make 0.108 revolution in the same direction as A. Did E revolve in the opposite direction to A, this would be shown by the answer being — 0.108.

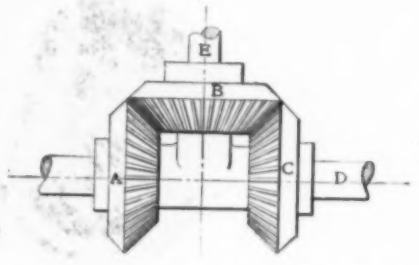


FIG. 2. A MITER-GEAR EPICYCLIC TRAIN

The reduction, therefore, by this mechanism

$$=\frac{1}{0.108}=9.25.$$

A Two-step Solution

This example has been worked out in three steps in order to show the application of the + and — signs. The desired result could, however, have been obtained in two steps, thus:

First Step Same as Before

Calculate, as before, the revolutions of the arm due to one revolution of A and no revolution of C.

This result we know is 13/36 revolution of the arm in the same direction as A.

The Second Step

Now calculate the revolutions of E due to no revolution of C and 13/36 revolution of the arm.

If the arm be held and C revolved, E will revolve in the same direction as C; therefore the sign for the value of the train will be +.

$$\frac{n-l}{a-l}=\frac{C\times D}{B\times E},\quad \frac{n-\frac{13}{36}}{0-\frac{13}{36}}=\frac{46\times 17}{31\times 36}$$

$$(31\times 36)\left(n-\tfrac{13}{36}\right)=-\tfrac{13}{36}(46\times 17).$$

This, worked out, will show n to equal 0.108, as before.

A Gear of Wide Applicability

An astonishing amount of variation can be obtained by this gearing, as will be seen by altering the numbers of teeth in the gears slightly and calculating the ratio; in fact, the velocity ratio is only limited by the pitch of the gears. A reverse motion can be effected by increasing the numbers of teeth in D or C.

A General Rule for Solving Epicyclic Gearing

It may be contended that there are shorter methods of analysis than the one advocated here, and I am quite prepared to acknowledge the fact; but, so far as my experience goes, these shorter methods are all of use only to their own particular combination of gearing, and should it become necessary to use a new, or slightly different, mechanism from the ones generally known, a new formula or expression has to be investigated, with great possibility of error. On the other hand, although epicyclic gearing may be divided into three distinct classes, viz., ordinary differential gearing, planetary gearing and bevel-geared epicyclics, this one simple rule is applicable to the whole lot.

Manchester, England.

A Gas Burner out of the Ordinary and Two Interesting Furnaces

Editorial Correspondence

We ordinarily think of gas burners as small appliances. The half-tones, Fig. 1, show us, however, that such is not always the case. They illustrate a natural-gas burner having an outlet diameter of 17 inches. It is used in rotary cement kilns in the cement fields of Missouri. The burner consists of a cast-iron body, a cast-iron nozzle and a wrought-iron sleeve which contains a series of ½-inch wrought-iron pipes arranged in a spiral, as shown by the lower of the two views. Each one of these ½-inch pipes has about ten 3/32-inch holes drilled along a line parallel to the axis and opening toward the nozzle of the burner. The gas is supplied through the tapped flange shown at the side of the body castings and enters an angular space which surrounds the wrought-iron sleeve. The open ends of the ½-inch wrought-iron pipes are flushed with the outside of this sleeve and open into this angular space; thus the gas enters these pipes and passes out through the 3/32-inch holes. The large number and location of these holes insure a supply of gas throughout the entire volume of the burner. Air is supplied through the larger end. The pressure for both gas and air is about 4 ounces. The length of flame which can be obtained from this burner can be varied by changing the volume and quantity of the air supplied. It can, however, be shot out to a distance of 40 feet from the end of the nozzle.

FIG. 1. A 17-INCH GAS BURNER

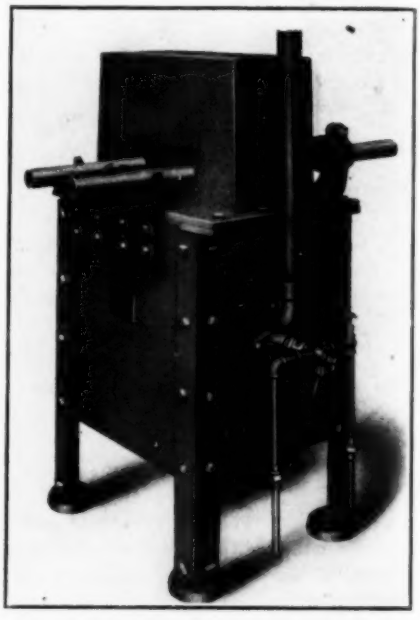


FIG. 2. A TUBE-WELD HEATING FURNACE

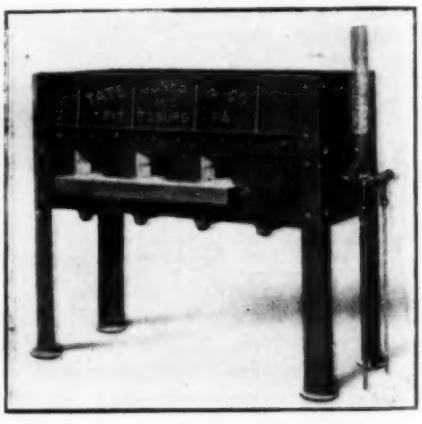


FIG. 3. A RIVET HEATING FURNACE

A Tube-weld Heating Furnace

Fig. 2 shows a recent development in a furnace for heating welds for locomotive-boiler tubes. It consists of a cast-iron frame supported on angle-iron legs. The lower portion is lined with fire brick, producing a wall about 4½ inches thick surrounding a good-sized combustion chamber. The fuel usually used is fuel oil, atomized by air at about 10 pounds pressure, and supplied with air for combustion at about 4 ounces pressure. The valves and burner are shown at the right-

hand end of the furnace. The upper part of the furnace, or the box-shaped section, into which the tubes are inserted, consists of a special tile. This has a 2-inch longitudinal slot, which connects with the combustion chamber on the bottom and the atmospheric air on the top. Through this tile are two circular holes slightly larger than the size of the flue which is to be heated. On the back of the machine and opposite these circular openings are stops, one of which is shown in the half-tone. These stops can be adjusted to give a safe end of from 6 to 12 inches as desired. In using this furnace only a small section of the tube is heated at the scarf, because the channel through which the hot gases pass is narrow. Again, as the gases pass through the top of the furnace, there is very little discomfort to the operator from the heat. It is claimed that from 60 to 100 welds an hour can be made on 2-inch tubes with a fuel consumption of from 2 to 3 gallons of oil.

A Rivet-heating Furnace

Our third half-tone illustration shows a type of rivet-heating furnace of which 50 were recently furnished to one of the new shops of the Standard Steel Car Company. These furnaces are capable of heating 500 ordinary-sized rivets per hour in each of the three openings, making a total of 75,000 rivets per hour for the lot of furnaces. These three interesting developments were seen at the factory of Tate, Jones & Co., Inc., of Pittsburg, Penn.

The famous Selden automobile patent issue was delayed until November 5, 1895. It still has five years to run.

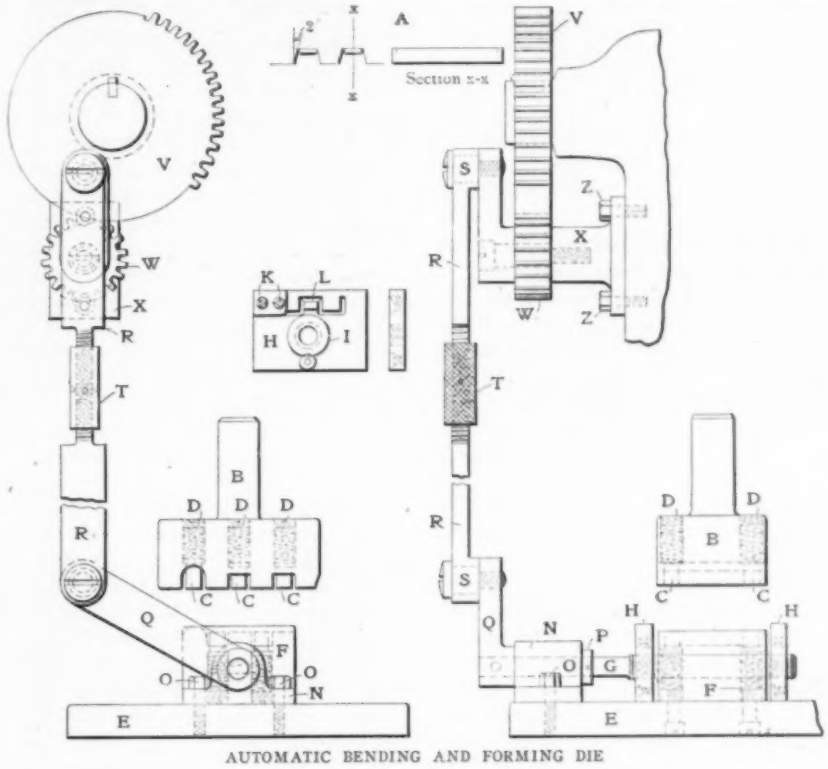
Novel Bending and Forming Die

By R. A. Almond

The die shown in the sketch was designed and used by a large metal-goods establishment for producing parts of sheet tin, shown on top of drawing *A*. As the chief feature sought in this line of manufacture is the reduction of cost and elimination of as many operations as possible, a die which allows the accomplishing in one operation cannot fail to be of interest. As a large number of these parts were required daily, the necessity for producing them as rapidly and as cheaply as possible was obvious without considering the expense of the die.

The sheet tin is 0.012 inch thick, 8 inches wide and comes in rolls 150 feet long. It is placed in a spool with a large washer on each side for guides. On the left-hand side of the press the metal is fed in by an ordinary automatic roller feed, and ratchet stops are used for adjusting to the proper length. On the right-hand side of the press sits a boy with a pair of shears which slide on rollers in a V-groove and cut the strips off to a gage mark on the bench, 38 inches long. The press runs at the rate of 125 a minute the whole day long without any attention whatever except when changing the sheet-tin roller, and that is done very quickly.

To produce the proper shape the press has to drop down three times by hand with the roller feed in use. The punch *B* is raised only high enough for the metal to slide through. This is done in order to guide the metal on top and bottom as well as on the sides. The first groove is 1/16 inch wider and rounded in the bottom so as to make it an easier bend. The second groove is finished to size with a 2-degree angle on each side. The third groove is left 1/32 inch wider but finished to size bottom and top. This was found necessary on account of a little variation about 1/64 inch on either side in the roller feed. If these grooves had to be formed exactly a certain dimension apart, a different design of feed would be necessary.



AUTOMATIC BENDING AND FORMING DIE

The three knock-out pins *C* have heads on the inside with a spiral spring between the stop screw *D*. The size of spring wire must be determined after a few operations, as it must not be so stiff as to mark the metal; at the same time it must be strong enough to force it out. The punch is hardened on the bottom and drawn to a light straw color for a lasting service. The die plate *E* is of cast iron, planed on top and bottom and fastened to the press with two straps. On top of the plate is located the die block *F*, with four screws and two dowel pins. After the die is assembled and set up with the punch in the press, it is further secured by soldering each end of the die block and then transferring all the holes from the plate to the die block, as this is the only way to line it up. The same press must be used at all times on account of all the parts belonging to it being fitted to the press. The die block is made in the same way and fitted to the punch with allowance for the metal between. It has a knock-out pin in each end of the grooves.

In the center is bored a straight hole to a running fit for the screw *G*. On each side of the die block is located a bending plate *H*. In the center of the plate a taper brass bushing *I* is driven from the inside and held in place with two screws, one on each side. These bushings fit the right- and left-hand screw *G*. In one side of the plate are driven two pins or three-cornered knives *K*, to split the side of the sheet tin with the first descent of the punch. In the middle, above the brass bushing, is an elongated square hole *L*, with the inside top corner beveled to a 45-degree angle, so the second descent of the punch can bend the side of the sheet tin. On each side of the elongated square hole is a groove 1/16 inch wide and 1/8 inch deep, milled to make room for the sides of the sheet tin while in operation.

The screw *G* is held stationary with a running fit in the block *N* and strapped down to the cast-iron plate with two screws *O*. On one side of the screw is placed a ring *P* with a dowel pin through it. On the other side is fastened a lever *Q* with a dowel pin through the screw end. On the other end of the lever is fitted the connecting-rod *R* made in two parts with a head screw *S* on each end and a right- and left-hand adjusting nut *T* in the middle. On the end of the press shaft is keyed an intermittent gear *V*. This meshes in with the pinion gear *W*, which carries the crank and drives the bending portion of the die.

Economies and Advantages of Grinding—II

By Selecting the Proper Wheels, Keeping Them in Good Condition and Using Them at the Right Pressure and Speed

BY H. DARBYSHIRE*

It is a disk or wheel built up from a numerous assortment of minute cutting tools which are held in position by a more or less friable bond. In using the wheel we must bring it to bear on the work with a pressure that shall not be so great as to tear these minute tools from their setting until their cutting efficiency is exhausted, for if we do so we are wasting the wheel. To gage the exact amount of the pressure required is a matter of judgment and experience, though where automatic feeds are provided on a machine the right amount of pressure or feed is soon determined. It will also be readily understood that a regular automatic feed is more reliable for the purpose than a possibly erratic hand one. The automatic feed may be set to give a certain depth of cut at each pass of the wheel, and its amount of wear noted; if this wear be found excessive the depth of cut may be reduced. It must not be here forgotten that work speed also enters into this consideration and that a high work speed will tend to wear the wheel excessively; inversely a reduced work speed will reduce the amount of wear. Having those points in mind the right combination of depth of cut and work speed is soon arrived at, and an approximate judgment attained for the future.

The amount of stock left for removal by the grinding wheel and the method of preparing the work have both much bearing on the economic use of grinding wheels, and to the writer's personal knowledge heavy and unnoticed losses often occur through want of a few precautionary measures. The necessary amount of stock to leave on a piece of work as a grinding allowance depends firstly on the type of machine employed, the class of labor engaged in preparing it and whether it has to be hardened or otherwise.

First as to the type of grinding machine: In powerful machines, say, of the Norton type, which will remove stock rapidly, the grinding allowance may be anything from 1/32 to 1/64 inch. This broad limit allows of expedition in the preparation of work in the way of coarse feeds, nor does it necessitate the same skill in preparation as would a more refined limit; but its maximum should not be exceeded unless there are special circumstances to warrant it.

*European instructing operator for the Norton Grinding Company.

Ignoring the Operator

It very often occurs that the complaints of the operator are ignored in the matter of too large an amount left for removal by grinding. Where piecework is in vogue this is the rule rather than the exception, but some little consideration will show that there is reason in his complaints. He has had his price most probably based on the removal of a given amount of stock and he not unnaturally wants to make the usual bonus. This, if his complaints are not listened to, will lead him to crowd his wheel on to the work in an abusive manner and though he may sometimes succeed in his personal object it is at the expense of his employer's wheel.

To avoid the limit advised being exceeded, rough tolerance gages may be provided with radial points so that the work may be gaged while it is in motion when being roughed down for grinding. When powerful grinding machines are used, there are many cases of an especial character when the grinding allowance stated may be exceeded to advantage so long as discretion is used. Straight shafts may often be ground direct from the black bar of raw material 1/16 inch above finished size, or when shafts of this character must have large reduction on the ends they can be roughly reduced in the turret lathe while in their black state and finished outright more economically in the grinding machine. Very hard qualities of steels or chilled rolls are other cases where it is often more economical to use the grinding machine without any previous machining process, and though there may be sometimes an alarming waste of abrasive material its cost is as nothing compared with other savings that are made.

It is at present an accepted fact that the use of high-speed steel obviates the necessity of casting or forging to the limits which were necessary before its introduction, it being found cheaper to bring the work to shape in rapid reduction lathes and other machine tools. The writer, however, has seen many examples of which the forging and casting were arranged for grinding without any previous machining and with extremely profitable results on work of a somewhat limited size. Grinding allowances for hardened work are usually left larger than for soft work, to allow for possible distortion; so that individual experience alone can determine the amount to be left. It is sufficient to say that the allowances on case-hardened or carbonized work should not be too excessive; otherwise the hardened surface may be ground away. To use a "bull," the easiest way to avoid troubles from hardening distortions is to see that they do not occur or at least to take all known precautions against their occurrence.

Grinding Hardened Work

As far as the actual grinding of hardened work goes, it is indispensable that the whole portion of a piece that is to be ground should be roughed over previous to the final finishing; if it is at all possible to allow some little time to elapse between the two operations so much the better, more especially if it has bent in hardening and been afterward straightened; this will allow of the development of any strain that may be present. Both for special and standard work in a factory a table of grinding allowances can be compiled as a result of experience and posted in a conspicuous position. If this be done and trouble taken to see that it is adhered to, it will save much trouble and be a means of avoiding much unnecessary expense.

Mention should be made of the necessity of slightly undercutting the corners of shoulders so as to preserve the corner of the grinder's wheel intact. A piece of work prepared in such a manner as will form a radius on the corner of the wheel is an abomination, for to get the wheel face flat again means much waste of wheel and wear of diamond tool. Where fillets or radii are necessary they are better got out with a tool, for even if they are to be ground they must be turned good to allow the wheel to conform to their shape. The only excusable reason for grinding a round corner is when the work is hardened or in some special case where the expense incurred is warranted.

It was remarked at the beginning that there was a very lamentable want of literature on the subject, so that the next best thing to do is to create some. One of the most useful educational methods in our public schools is the practice of essay writing and in the after more strenuous life its purpose is just as useful. You have only got to begin to write about a subject and you soon realize how little you know of it below its surface and how much there is to be learned. It leads to a concentration of thought and research of acknowledged authority which is useful to the individual who writes and which must have some value to those who both read and criticize. The pages of this and other

journals are thrown open for the reception of discussions and descriptive matter on this and other kindred subjects, which is an opportunity that should not be neglected. No one is so lacking in knowledge but what he can contribute some little point which may possibly solve a greater difficulty, and the bare fact of writing about it may be educational to him in many unforeseen ways.

Believe in Wet Grinding

The question was raised in this paper some time ago as to whether internal grinding should be done with water. One of your correspondents raised an objection to the practice on the ground that water interferes with the cutting efficiency of the wheel. Personally I am inclined to think that his reasons are to some extent imaginary, or it may be due to applying the water at other than the right spot. This spot must be right at the *grinding point,* whether it be internal, external or plane-surface work, and must be delivered with sufficient force to keep the wheel face clean. If this is not done there is a kind of mud accumulated at the grinding point, which causes glazing. Water is, or should be, used in grinding processes not as a means of quenching heat but rather to prevent its creation and radiation, and so the actual grinding point is the best place to apply it.

It is a necessary means of keeping the work at an equable temperature so as to obviate distortion and to make the matter of taking dimensions an actuality rather than a guessing matter. This applies equally to all kinds of grinding and my personal experience is quite opposite to your correspondent's in the matter of output. By the use of water in internal grinding I get a greater output, a better finish and work which is more uniform in size than I did previous to introducing it. Even granting that the trouble complained of does exist, the other advantages more than compensate for it, and for hygienic reasons alone it is commendable. As for the complaint of excessive wear of grinding spindles it must be considered that their journal area is of unavoidably limited size and their speed very high; they need renewal from time to time, but this is not a big job. Probably the lubricant the writer uses may be at fault as this often gives trouble with these small spindles. I have found a mixture of two parts viscolite oil to one of kerosene the best in my case, with an occasional flushing out with pure kerosene. Certainly the rapid wear of his spindles is peculiar if due to wet grinding. I have noticed particularly that in my case they have run a comparatively longer period without taking up for wear, and I have given the water credit for this in preventing the overheating that formerly occurred.

The Use of Diamonds

Before closing this matter it is perhaps as well to give the question of diamonds some little consideration as they are a sometimes very expensive item. A diamond is a very essential part of a grinding machine's equipment for in its absence a good and highly finished grade of work is an impossibility. It is perhaps unnecessary to state that they should be the hardest rough stones procurable, and that the larger they are the cheaper they are in the end. With regard to their size: This is a known proportionate element in their price per carat, but a large stone allows of a more secure hold in its setting and so the danger of losing it is reduced. As a further precaution against this danger the diamond tool should always be held by mechanical means when using it except in cases which are unavoidable; this may be in cases where profile shapes have to be turned on the wheel face. An attempt to turn by hand a perfectly flat face on a wheel, which is necessary for finishing, must of a necessity end in failure, putting aside the risk of grinding away the setting.

There is often a somewhat pardonable reluctance to supply each separate machine in a grinding plant with a diamond, but it is not difficult to prove that it is a mistaken economical idea. If one diamond is allotted to two or more machine operators there is no one directly responsible for its care and it must naturally have the total wear of an adequate supply. Another point to consider is the loss of time incurred in chasing around for it by the man who wants to use it, and the not unusual chat with the workmate he finds in possession of it. As a preservation of the diamond a full stream of water should be run on it when in use and many light chips are preferable to a few heavy ones. The main thing to watch is that it does not get unduly heated, for this is disastrous to it. Where large quantities of material have to be moved from a wheel the ordinary wheel dresser may be employed to reduce the bulk of the stock and the diamond only used for finishing to shape.

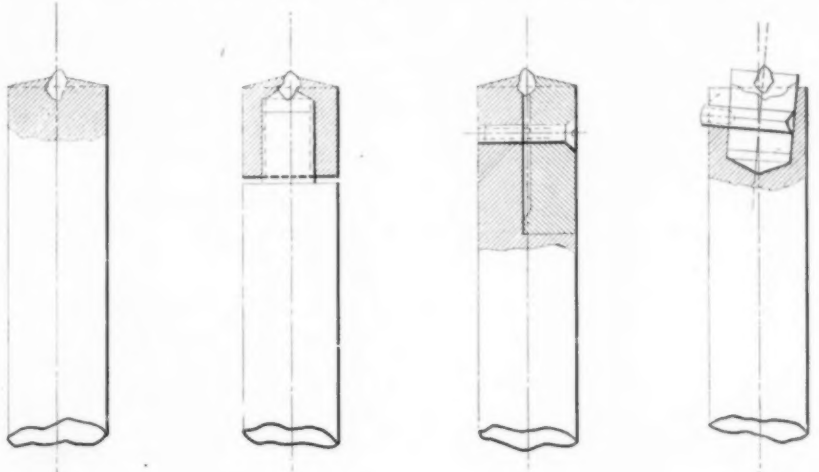


FIG. 5 FIG. 6 FIG. 7 FIG. 8

METHODS OF SETTING DIAMONDS

Setting the Diamonds

Diamonds may be obtained ready fixed in suitable holders or the rough stones may be bought and set by any competent toolmaker. The illustrations show various methods by which they may be held securely and require but little explanation. First, Fig. 5 is the method most commonly used, the diamond being either peened or brazed in position. One disadvantage of this method is that the diamond is apt to break with a chance blow of the peening chisel, or the heat from brazing will sometimes cause fractures; neither is it so easily reset when its point becomes dulled as are the other methods shown. Fig. 6 requires no explanation except that it is advisable to pack the diamond with shredded asbestos fiber to act as a cushion; this method allows of quick resetting. Fig. 7 consists of a small steel cap tapped out to fit the stock as shown. Enough shredded asbestos fiber is inserted between the diamond and stock to hold it firmly in position. This method also allows of quick and safe resetting. The fourth method, Fig. 8, is I believe covered by patent rights and its advantage can be seen at a glance; as the diamond wears, the small peg containing it can be revolved in the stock to present a new cutting edge and be so clamped in position. Diamonds should be kept fairly sharp and as their points wear off they should be reset to present their next best one. When worn quite round they can usually be sold to the diamond dealers who can find other markets for them. Don't let the diamond get too blunt or it will burnish the face of the wheel and so cause it to glaze and burn the work.

There is no grinding job known to the writer that will allow of the operator loafing alongside the machine, that is, loafing in the sense of what is usually witnessed and tolerated in other machine tools. The lathe or planer hand may so arrange his machine that it will dispense with his at-

tention for a protracted period, but this can never be the case with the grinder hand. Given that suitable wheels are used, its operations are so rapid that it demands a constant attention and concentration of thought on the work in progress. Yet its very opposite is a condition that may often be witnessed. If we visit one of these grinding shops whose supervisor is not a live man, there may be seen an exhibition of complacency that is painful to observe. We see operators standing by machines in an attitude that recalls memories of soldiers on sentry or policemen on their beat. They have a wheel made of some unyielding substance, which is absorbing an excess of valuable generating power and which is supposed to be grinding, but which is mostly acting as a brake for the line shaft. It goes without saying that some amount of work is accomplished in these places on the principle that "constant rubbing will wear away a stone," but where is the sense or economy in it?

Keep the Wheels Sharp

When a lathe or planer tool, a boring or milling cutter or any other integral cutting gives evidence of non-efficiency, we either dress it or replace at once as a natural precaution against waste of time and indifferent work. So with a grinding wheel that is too hard or otherwise unsuitable. Unfortunately you cannot cure it with the grindstone, but you can change it for a softer or more suitable one. It is with grinding as it is with all other things, that a superficial knowledge of the subject will only afford commensurate results. To obtain its full benefits one must be prepared to go below the surface, and the grinding-machine operator is not outside the pale of this advice. If he is an earnest worker the adverse conditions stated will set his thoughts at work and provided he is listened to, he may save his employer much expense. He will set his wits to work and employ such means as will make him familiar with the tools he works with and so be able to humor these peculiarities.

The opposite type of individual is too well known to discuss his attitude in the matter, and it may be summed up as one of indolent apathy. Modern grinding practices require that whoever takes up the operation of machines shall have an open mind and be able to receive impressions which are sometimes opposed to previous machining processes. For these reasons the average good mechanic does not always make a successful operator, he being in many cases too conservative or stupid to absorb any impressions opposed to his past experience. On the other hand, mechanical knowledge is essential, for there are many things outside the actual grinding of which a knowledge is requisite, and the job throughout is one of some responsibility.

Grinders Should Be Skilled Men

The work which the grinder receives is usually of a class that previous labor has been expended on, sometimes at considerable expense, and if he be not a careful and observant worker his slips may prove costly ones to his employer. Bright and ambitious youths who have had some little shop experience are the best material to train from, and if they be encouraged pecuniarly they invariably make good and rapid operators. Totally unskilled labor, if employed, usually proves a costly investment until such time as sufficient experience is acquired, the care of the machine alone being one item to consider.

A grinding machine is a tool provided mostly for correcting the errors of other machine tools, so that its most efficient condition must always be maintained. All belts should run smoothly and without shock or jar and their joints should be so made as to insure this. As it is a machine with rapidly rotating parts, a good or special quality of lubricant is necessary and should be administered freely. All slides and moving ways should be kept free from gumming, so that they shall always move freely and cleanliness is everywhere essential.

There is a class of operator who neglects these precautions to such an extent as to make the operation of his machine impossible to others than himself. This is the individual of whom it may be said that his muscularity increases as his machine deteriorates, and his type is not peculiar to grinding machines alone. A machine in this condition is an ever present danger to the work it is engaged upon, and the negligence responsible for it cannot be too quickly curtailed. A periodical flushing with kerosene is not much trouble and will insure the freedom and easy running that is necessary.

Planing Fixtures for Round-edge Keys

By R. H. Wadsworth

Upon assuming control of a machine section in an engine-building shop, the first thing to attract my attention as providing a field for improvement was the method of making round-edge keys. These keys are used in bolting the two halves of fly-wheels together, when the fly-wheel has a rim section which is nearly square. The keys are used in pairs; two parallel and two tapered keys and two key bolts are required for one wheel. The key bolts are square in section with two holes mortised through them. A parallel key is inserted in a machined slot through the edges of the wheel and through one mortise in the key bolt. This operation is repeated at the opposite side of the wheel. Then this half wheel with its two key bolts is fitted to the other half; sizes are taken for taper keys and they are made and driven into place. The keys vary in size from 2¾x8 inches to 1x3¼ inches. They are made of tool steel.

These keys, when planed on two sides and cut to length, were laid off for centers and drilled with a combination center drill. In the laying off of the centers there were some inaccuracies and others in the drilling, so that when these keys were put in centers on the planer they would plane neither parallel nor to size. Much time and patience were consumed in drawing the centers by peening and gouging, and the resulting work had a disgraceful appearance about the centers.

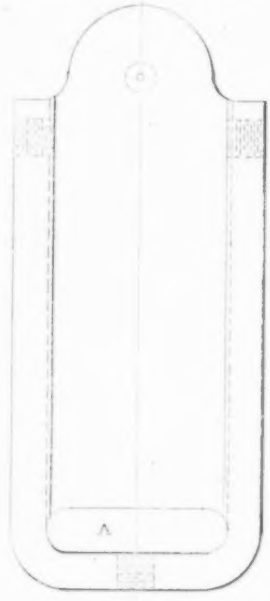


FIG. 1

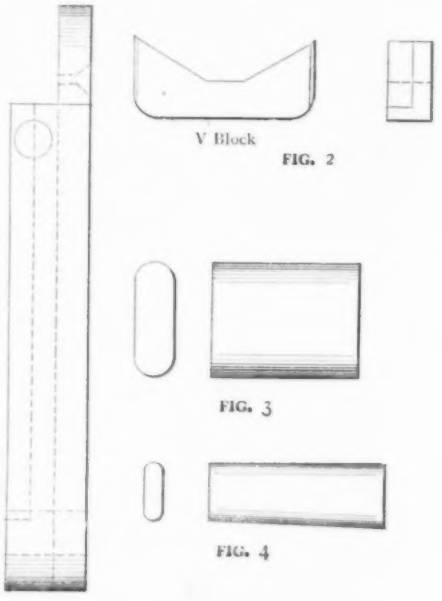


FIG. 2

FIG. 3

FIG. 4

FIXTURES FOR PLANING ROUND-EDGE KEYS

I therefore designed and made a pair of fixtures to make one size of these keys, namely, 1¼ inches wide. It was afterward found that keys 1 inch wide could also be made in them. The success of these fixtures was so complete that other sizes were made. As may be seen from the illustration, when a fixture was put on each end of a key and put between centers, the key could be alined to its proper relation to the centers by moving the set-screws in the fixture. An eighth of an an inch of clearance for adjustment was allowed in width between the key and the jigs on small sizes.

The total time formerly consumed on a pair of keys was never less than five hours for laying off, drilling and planing. This figure, however, includes some delay in transferring from one operation to another. Frequently this time was more than a day, due to delays between operations. With the fixtures a pair of keys were made in two and a half hours.

The first pair of fixtures made had a set-screw on each side near the lower end instead of the little V-block shown in Fig. 2, which is fitted into the jig to slide

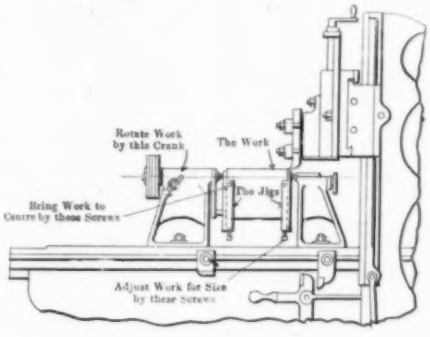


FIG 5. PLANING ROUND, EDGE KEYS IN USE

freely up and down. The V-block style gives better satisfaction.

Fig. 3 shows the key for which the fixture which is shown was made; Fig. 4 shows a smaller taper key, while Fig. 5 shows the fixtures in place on the planer platen.

A new method of cutting steel is said to have been patented by a Belgian engineer. The process consists in first heating the metal by means of an oxy-hydrogen flame and then cutting it by a small stream of oxygen gas, which unites with the steel and forms a fusible oxide, which flows freely from the cut. It is said that the cut is fully as smooth as that made by the saw, and is only 1/100 inch wide.—*Scientific American.*

According to the *Railroad Gazette* the record of railroad accidents in the United States occurring during the month of August totaled to 46, of which 18 were collisions, 25 derailments and 3 boiler explosions.

A Novel 16-Spindle Drill

The real novelty of this design is not shown in the general view, even though it is decidedly unusual to see 17 separate motors on a drill press, one for each of the 16 spindles and one for moving the table and the work up to the drills.

The advent of high-speed steel for drills proved to the Crane Company, Chicago, that the multiple drills already in use were not strong enough to stand the increased speeds and feeds. This machine was designed by their own engineer, who is to be congratulated on the boldness and novelty of his design.

FIG. 1. A NOVEL 16-SPINDLE DRILL

In order to avoid complicated mechanism, each spindle is driven by a separate motor which has sufficient power to handle the largest drill used in the machine—1⅝ inches in diameter. The real novelty of the design is shown in Fig. 2, which is a side view showing one of the outer columns in the center. The motor *A* is mounted on the frame *B*, which rests on the base plate *C*, but is free to move in or out on this base to any desired position, and gives any bolt circle between 3⅛ and 36 inches.

It will be noted that each drilling unit, which includes the motor, base, gearing, drilling frame *D* and *F* and spindle *C*, is not fastened in any way, but rests on the base plate *C*. The upward thrust is taken by the plate *E* over the frame *D*. It was planned to magnetize the holding plates *C* and *E* to hold the drilling unit in any position, but this has been found unnecessary in actual practice.

All adjustments of this machine, necessary to change for different sizes of work, are made without the use of wrenches, drifts, or any sort of tool. Only the fingers of the operator are necessary. Drills may be set all at the same level and time in a few seconds, simply by turning the adjusting nuts, which may be seen in the details of Fig. 3.

Each drill spindle is driven by a sleeve coupling which fits onto the shaft of the motor through a pair of special angle bevel gears and a universal joint. There is no feed attached to the drill spindles, the work being fed up to the drills from below.

The table upon which the work rests is capable of feeding from 2½ inches to 50 inches from the floor, and it is driven by a separate motor provided with changes of speed for the feed. There also is a quicker movement up or down for adjusting the table to the work.

The table is pivoted at its center, so that while a piece is being drilled upon one end, the other projects beyond the upright frames in order that another piece of the work may be made ready and swung into position under the drills as soon as the piece on the other end is finished.

The drills used are twist, specially made without a shank, and are 24 inches long when new. They may be used until there is only 2½ inches in the socket. The drill is held from turning by the holder at the bottom of the spindle, which is provided with lugs fitting into the flutes of the drill. The holder is inserted with the drill, a slight turn backward preventing it from falling out and bringing it against feathers in the spindle. Fig. 3 shows full details of this.

Any upward movement of the drill due to thrust is prevented by a threaded nut fastened adjustably to the top of the drill, this being turned so that the threads on the nut engage with the threads on the inside of the spindle.

As may be understood from reference to the detail, the nut at the top of the drill is ground, so that the drills may be kept the same hight.

Spindles not needed may remain idle, so that power is used only for the number of drills required, whether that be one, two, or any number up to sixteen.

We are indebted to the Crane Company and its publication, the *Valve World*, for these illustrations.

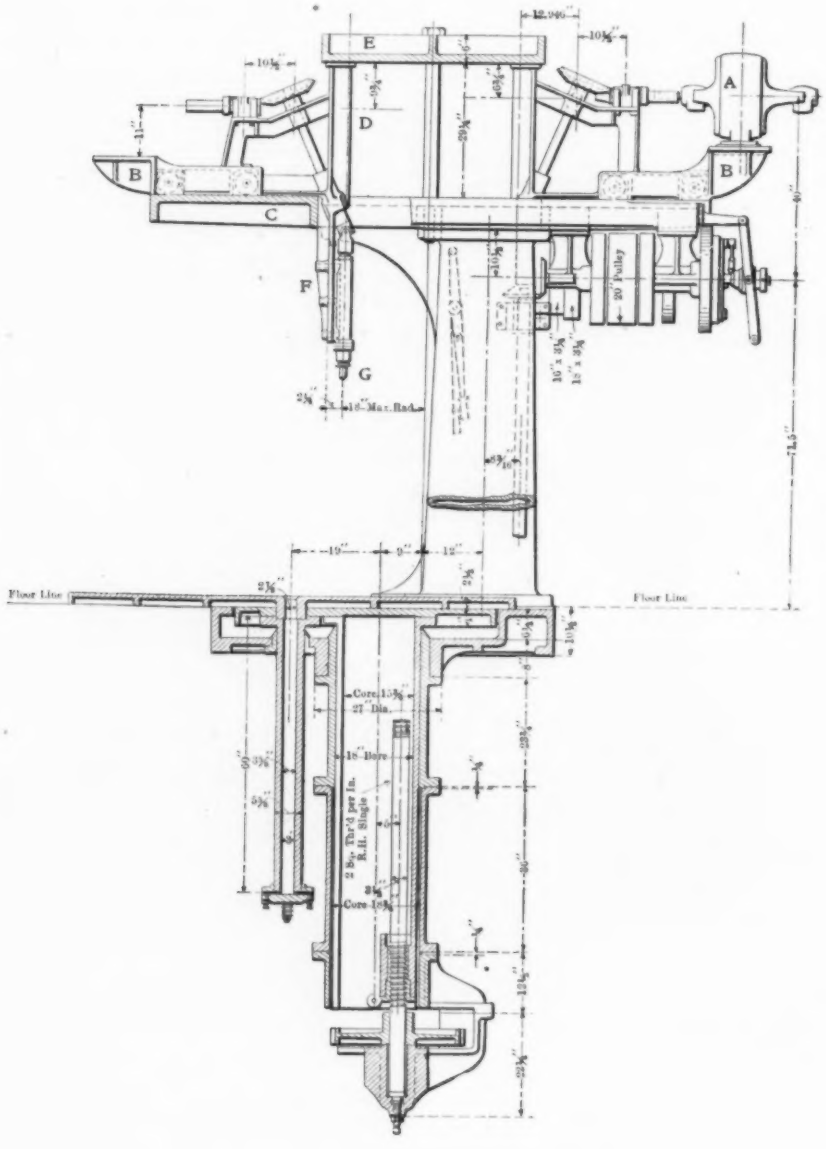


FIG. 2. DETAILS OF MACHINE ITSELF

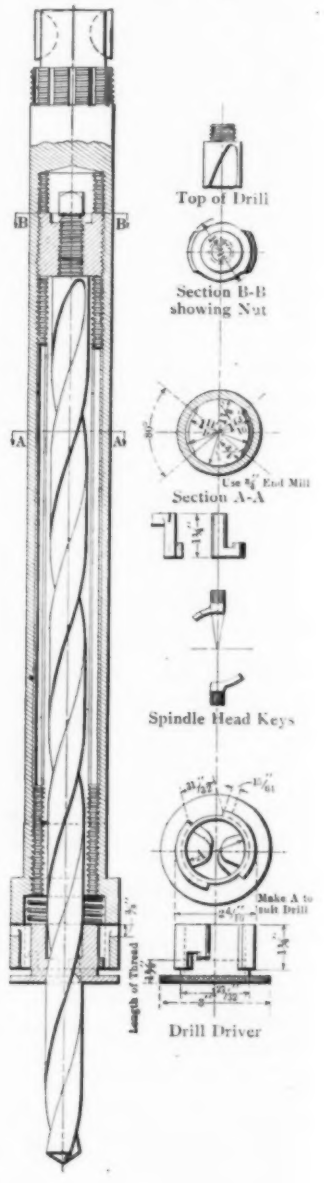


FIG. 3. A DRILL AND HOW IT IS DRIVEN

Paper making in Japan has been very active for the past year or so. New companies have been formed, and old ones enlarged. Most Japanese mills use steam for motive power, and nearly all the machinery used is of American make.

Cutting a Quick Pitch Screw in the Lathe

By Wm. V. Lowe

Every little while the toolmaker has a problem to solve which is out of the ordinary and of such a nature that he has not the tools which he would usually choose for performing the operation. Among such cases comes the cutting of a screw of such lead that it is beyond the capacity of the tools ordinarily found in the shop. Such a problem came up the other day, which was, in brief, to cut a quadruple-thread screw, 2¼ inches outside diameter, of 2-inch lead and with an Acme thread. The threaded portion of the screw was about 8 inches long. This screw would have been cut on a thread-milling machine, but there was not a machine of this kind in the shop.

We considered cutting the screw in the universal milling machine, but discarded this plan when we considered the tools required, that if the thread were cut with an end mill the cutter would be fragile and slow in operation, and that there were several screws to be cut. It was finally decided to cut them in a lathe. The pitch of the lead screw of most lathes suitable for this work is four to six threads per inch; this would give a large ratio between the gear on the spindle and that on the lead screw.

Previous attempts to cut a screw of about this pitch caused great trouble from broken gears, and parts of the lathe bent or sprung out of position. At this stage we recalled a device for cutting screws, which we had seen successfully used in another shop some years ago. This device consisted of a leader of large diameter screwed to the spindle of the lathe, and by suitable connections causing the lathe carriage carrying the tool to move back and forth independently of the lead screw. The particular one we had in mind was 14 inches in diameter and used in a lathe of 16-inch swing.

Following that idea, we first picked out a gray-iron casting *A*, Fig. 1, about 2 inches longer than the thread we had to cut. This casting was about 5 inches in diameter and was fitted to the lathe spindle at one end, the other being bored out a close fit for the bushing *B*. After turning, the casting was taken to a milling machine and a spiral groove *C* milled in it by an end mill. The size of this end mill does not matter; we used one about ¾-inch diameter and fitted a roll *D* to work easily in this groove. The roll turns on a stud which is fastened in the angle plate *E*, which in turn is fastened to the lathe carriage by the bolts shown. As the lathe spindle revolves, it causes the lathe carriage and therefore the tool in the tool post at *F* to move according to the leader *A*. The end of the screw blank to be cut is clamped by a set-screw *G* in a bushing *B*; this bushing has a collar milled with four slots fitting over a pin *H*. After one thread is cut the proper depth, the screw *J* is withdrawn from *A*, turned quarter way round and bushing *B* slipped over pin *H*, ready for the second thread.

This arrangement worked very well indeed. The leader *A* overhung so far that there was a little tendency of the tool catching it and hogging in if crowded. If satisfactory connections could be made, by attaching the leader to the tail end of the spindle, so as to support the screw on short centers, this difficulty would not occur. A slight modification of the above will admit of supporting the end of the leader in a steady attached to the lathe bed.

This particular screw worked in a babbitted nut, so the question of threading the nut did not trouble us; but a slight modification of the above would allow the nut to be held in the leader *A* and indexed around for the different threads. The best we can say for this fixture is, it worked and enabled us to get the work out.

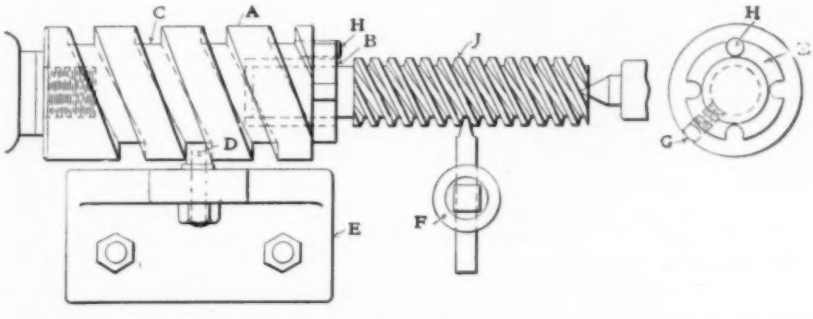


FIG. 1. THE FORMER USED IN CUTTING 2-INCH PITCH SCREWS

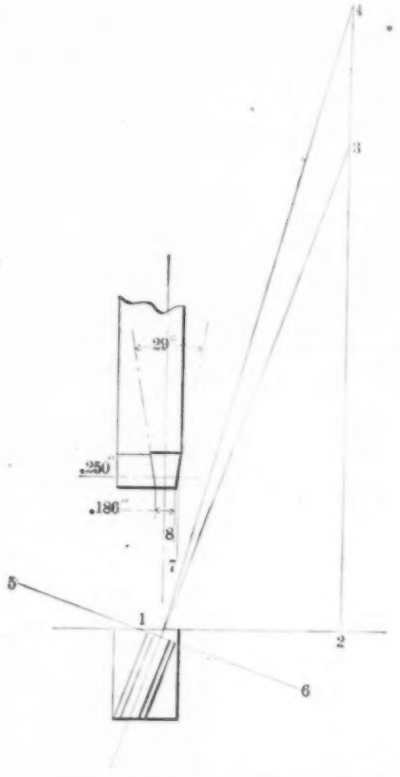


FIG. 2. LAYING OUT THE ANGLE OF CUTTING TOOL

I think it will be readily seen that this device is not necessarily restricted to screws, since in some cases, limited it is true, the leader *A* might be cut with a groove other than a helix and used to guide a tool in the tool post for performing a cam-cutting operation, usually considered possible only on a milling machine. We think we cut the screws referred to in less time than they could be done in the milling machine, and the thread was left free from any chatter marks.

It is very important that a proper cutting tool be used and that it have such an angle as will clear the work and still have plenty of metal in it, to avoid chatter. In order to show how this angle is determined, I show a diagram, Fig. 2, illustrating this point. We may lay out this angle graphically or calculate it, as may be most convenient, the former preferred. Draw a horizontal line 1-2, in this case 2 inches long; this represents the lead of the screw. From the extremity erect the perpendicular 2-4. The length of this line is equal to the circumference of the outside of the screw, in this case 2¼ inches diameter, or 7.0686 inches circumference. Join 1-4. The angle 4-1-2 represents the angle of the thread of the screw on the outside surface of the screw.

The diameter at the bottom of the thread is 1¾ inches, circumference equal to 5.4978 inches. Lay out point 3, 5½ inches from 2, and join 3-1. Angle 3-1-2 is the angle at the bottom of the screw thread and illustrates at once one difficulty in cutting very quick pitch screws of small diameter, for it will be seen how the angle increases with a decrease in the diameter of the screw.

The angle to which the face of the tool is set is usually the angle at the bottom of the thread 3-1-2, although an intermediate angle between this and 4-1-2 might be chosen. The proper shape and dimensions of the cutter are laid out on the horizontal face of the tool.

The front of the tool is then cut down to the angle shown. The front of the tool is given a rake of about 10 degrees; after the tool is finished, the upper surface is cut away at right angles to the end, as shown by 5-6. This allows the tool to cut without drag.

As an instance to show the vast growth of the use of dies for forming pieces formerly made by hand, G. H. Steward, in a paper before the Master Blacksmiths' Association, pointed out that at the Altoona shop of the Pennsylvania Railroad they have complete sets of dies and formers for making all parts of steel passenger, baggage, mail and dining cars from the deck molding at the top to the trucks, excluding the welding of the rods and similar parts. In all there are 1054 dies in use at these shops.

Pressure Pumps with Automatic Release for Low-pressure Cylinders

These triplex tandem compound pumps, such as shown in Fig. 1, are especially designed for the operation of hydraulic presses, baling presses, filter presses, riveting machines, forging machines, testing machines and other apparatus in which there is a certain amount of lost motion to be taken up, or an operation started at low pressure and high speed and the work completed at high pressure and decreasing speed.

Each pump has three high- and three low-pressure cylinders arranged in tandem, which are very carefully alined and so connected that all six cylinders discharge into the hydraulic press. The line drawing shows the arrangement of these tandem cylinders, the low-pressure being 2¼ inches in diameter, but having only the area of the annular ring around the high-pressure rod or plunger. The high-pressure plunger is 1¼ inches, making the area 1.227 and 2.749 square inches respectively.

At the side of the pump are the relief valves *A*, one for each pair of pump cylinders.

One of the principal features of the pump is the automatic release for the low-pressure cylinders. In order to illustrate this we refer to Fig. 2.

When the pressure rises to a point where it presents danger of overloading the pump, heating bearings, etc., the low-pressure cylinders are cut out by an automatic relief valve, and the load is thrown on the smaller diameter high-pressure plungers, where it may safely reach a maximum of 2000 pounds per square inch.

The operation of this mechanism is as follows: When the pressure reaches 500 pounds to the square inch, for example, it exerts a pressure of 150 pounds on the special ram ⅝ inch in diameter, which is in direct communication with the discharge port of the low-pressure cylinders, thereby pressing down a lever, with a short fulcrum, which raises from its seat the suction valve in each of the low-pressure cylinders. This breaks the suction in those cylinders and puts the work entirely on the high-pressure plungers, which finish it at decreasing speed.

If the character of the pressure required is intermittent, making it necessary to throw the low-pressure cylinders in again, the automatic-relief arrangement operates equally well on the return movement; for, as the pressure goes down, the special ram attached to the lever is forced upward by a counterweight and the valves are re-seated, thereby putting the load once more on the entire pump. The automatic relief can be set, by means of a counterweight, to operate at any required pressure up to that maximum.

As an example of the advantages of this pump, operation in connection with a baling press may be cited.

In a baling press the material to be baled is very loose at the beginning of compression; but as the bale becomes tighter, more pressure is needed. Under such and similar conditions the pump can deliver a large quantity of water at low pressure until, as the density of the bale increases, the low-pressure cylinders are thrown out automatically, in the manner above described, and the high-pressure plungers finish the work.

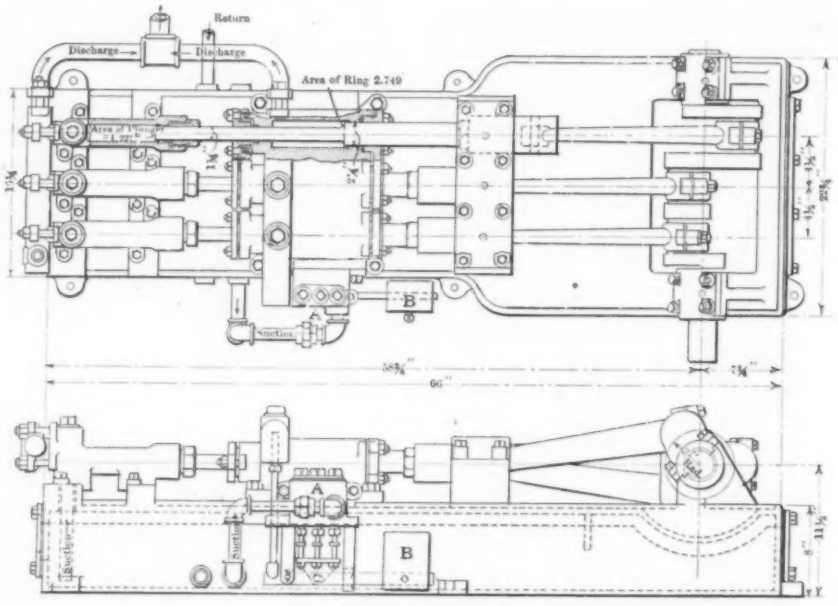


FIG. 2. DETAILS OF TRIPLEX-COMPOUND PUMP

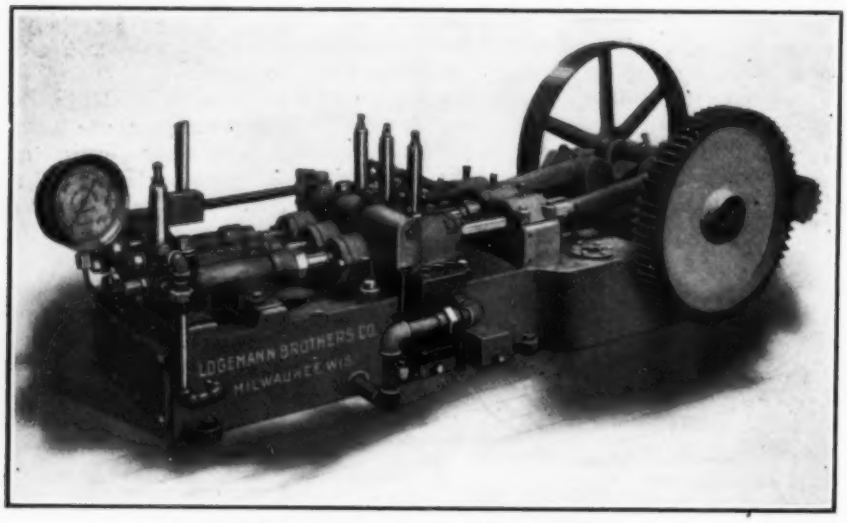


FIG. 1. TRIPLEX-COMPOUND PUMP FOR HYDRAULIC PRESSES

In presses also where dies of various patterns are used, the combined plungers of the pump quickly raise the ram of the press until the dies are brought together, when the work is completed by high pressure alone.

Furthermore, the pump can be adapted to work of a similar character. For instance: A harvester manufacturing company is using this pump in connection with the operation of pressing shafts on large mower frames. From four to six hundred shafts are handled per day. For the greater number of them the six plungers of the pump are used; but a certain percentage of the shafts go on very tight. When one of these shafts is encountered the low-pressure cylinders of the pump are thrown out and only the high-pressure used. The combined pump plungers give a speed to the 6-inch ram of 18 inches travel in six seconds. It is only when a tight shaft or even tight places in these shafts appear that the low-pressure cylinders are automatically relieved and the work completed at decreasing speed.

In some cases the pump can be used to advantage in place of accumulators.

This pump is made by Logeman Brothers Company, Milwaukee, Wisconsin.

Compression of Cast Iron in Machine Construction

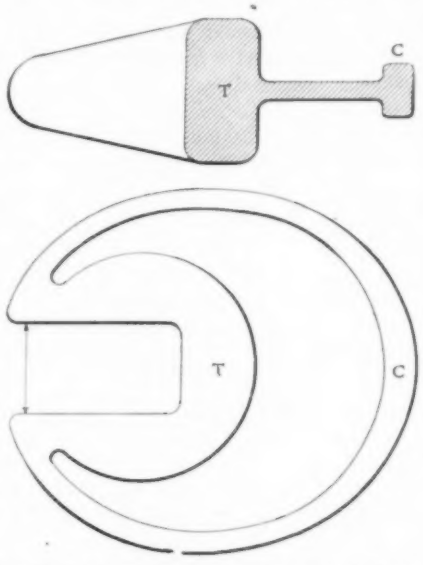
By James Christie*

In the middle of the past century as cast iron became extensively applied to structural purposes, its physical properties were studied with great care, and the experiments of Hodgkinson and Fairbairn in England, and their contemporaries, yielded a fund of information on the subject. Seeking a section of beam which should exhibit the highest ultimate strength in proportion to area of cross-section, or of the weight of metal employed, Hodgkinson advocated a section in which the tension flange exceeded the compression flange about six to one in sectional area, the web usually tapering in thickness from the tension flange, diminishing toward the other flange. This form of beam was largely adopted, and took precedence as long as cast iron was used for beams in structures. We find that the same method of reasoning influenced the machine designer in disposing of cast iron to seeming advantage in the construction of machines, massing the metal to resist tension, and permitting high unit stress on metal in compression; and especially is this observed in machines of the open jaw or gap type, such as presses, punching and shearing machines, etc.

I believe that usually the unit stresses should be little, if any, higher in compression than in tension, for the following reasons: In machinery rigidity or stiffness is usually the chief consideration; many machines do not fulfil the intended purpose properly, not by failure through fracture, but by a want of sufficient stiffness. Deflection has to be limited, and when that is done, breaking from excessive tension is sufficiently guarded. Remembering that cast iron yields to compression, as much as with the same unit streses it yields to tension, it follows that the compressive stress should not exceed the tensile strength per unit of section if it is desired to dispose a given mass of metal with least deflection. It is believed that rupture sometimes occurs in a machine apparently through tension, where the origin of the weakness could be traced to a want of material to sufficiently resist compression, the improperly supported tension side severing by cross-bending or transverse stress.

Taking for illustration an open-gap machine with frame as illustrated, tension at *T* and compression at *C*, if the section is so shaped that compressive unit stress is six times that of the tensile unit stress, then, elastic moduli being equal, the frame will yield at *C* six times as much by compression as it does by tension at *T*. This permits an oscillation of the mass at *T* around its center. If this oscillation becomes dangerous, by extent or frequency, the frame will break by cross-bending at the mass *T*, giving the impression that more material is needed to resist tension, whereas the fact may be that more material should be placed at *C* to prevent excessive yield by compression.

Owing to the peculiar physical characteristics of cast iron, it has not been found practicable to harmonize experiments with the theory of flexure. Many reasons are offered for this, and modifications of the usual accepted theory have been propounded which will not be discussed here. It has been found necessary to introduce into the equations moduli or coefficient which have no apparent



COMPRESSION OF CAST IRON IN MACHINE CONSTRUCTION

relation to the direct strength of the metal, and which vary widely for different dimensions and shapes of cross-sections. As the cross-sections under consideration are frequently of unsymmetrical and irregular shape, the computation of flexural moments is tedious and frequently useless if the computer has not a correct modulus to apply to satisfy the conditions of the section under consideration. It is therefore desirable for the designer to keep a record of experiments, and of failure of castings under known loadings, and from these results derive coefficients, by means of which the strength and stiffness of various sections can be approximately known without recourse to the usual calculation for the resisting moments of the section.

In machinery the working stresses are usually impulsively or suddenly applied, sometimes with actual percussion or impact, and frequently alternate stresses of equal intensity in opposite directions occur in rapid reciprocation. As it is known that a load so rapidly applied as to permit the unimpeded effect of gravity will produce a deflection double that due to the static effect of the same load, it can be seen that the total amplitude of vibration due to rapidly alternating loads must be very considerable. To prevent excessive vibration, the structure should be designed with a limitation of deflection in view, and the amount of this limitation is derived solely from experience, and should be governed largely by the nature of the service to which the material will be applied. For machinery under ordinary circumstances we might assume, in order to obtain satisfactory stiffness, that the deflection should not exceed 1/2500th part of the span, and under certain conditions, should be much less than this. Indeed, it is quite probable that a deflection in direct proportion to length is not advisable, but that the ratio of deflection to length should decrease as length is increased. For long members in compression, the sectional area must be augmented as the ratio of length to cross-section increases, but for members under variable tension alone the section should be increased also, or the stress per unit of cross-section reduced, as the ratio of length to cross-section increases, for the purpose of reducing vibration due to successive extensions. When rapidly alternating stresses occur, it is acknowledged that provision must be made for something more than the greatest stress in one direction alone. There are still differences of opinion and practice on this subject among bridge designers; some maintaining that when the alternations are of slow recurrence, so as to permit actual rest between reversals, no special increase of section is required; others specify that the sum of the sections required for the stresses in opposite directions should be used to suit the conditions. There can be little doubt that the latter estimate is little enough for machinery when the oscillation of the forces occurs with great rapidity, and especially when the metal under consideration is cast iron, with a modulus of elasticity about one-half that of steel or wrought iron. It is a safe general rule for ordinary cast iron in machine structures to limit tensile stress to 4000 pounds per square inch of section, under the most favorable circumstances; to 3000 pounds when loads are suddenly applied, and to 2000 pounds when the force alternates in direction; these unit loads to be further limited to suit the ratio of length to section, as required for columns or any members in alternate extension, or compression, or for beams or members subjected to alternating transverse stresses, the unit stresses on the material should be limited so that the sum of the deflections in opposite directions will not exceed one-twenty-five-hundredth part of the span.

*Extracts from paper before the Engineers' Club of Philadelphia.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Movable Bushings

These movable bushings are used on jigs when the work is drilled and reamed or drilled and tapped at one setting without removing the work from the jig. But, instead of making just one bushing for the drill and forcing it home in the jig, we make a stationary bushing having the hole to receive the movable bushing bored true for location and then force the stationary bushing in place, as shown in the cross-section.

We then make one bushing for our reamer drill and one for the reamer which will be the finishing size, with *B* a close sliding fit in the stationary bushing to insure accurate work. In tapping holes in the same setting, only the tap-drill bushing is required, as the aperture of the stationary bushing will give sufficient clearance for the tap.

All bushings should be made of tool steel, hardened and ground, to give the best results. The stop shown is to prevent the movable bushing from revolving with the drill, which is essential. It can be fastened in place after the stationary bushing is forced home. The 60-degree angle of slot in bushing will permit a movement of 40 degrees, which is handy in extracting the bushing.

Having used this method in several shops, I feel safe in saying the proportions of the bushings shown forms a suitable standard. WM. METZROTH.

Speeds and Feeds in Geometric Progression

Mr. Parker's article on page 429 is very instructive, and undoubtedly will be of advantage to those having such speed and feed designing to do. Like most writers on this subject he in a way, makes an apology for favoring the geometric progression of increase. I do not think this is necessary, because it is the only practical way in which we can plan it. We can lay out the cones as we like, but when it comes to the back gears we have to take what we can get.

Assume for instance that we want eight speeds decreasing, not in a ratio, but by a certain number of revolutions, as follows: 400, 350, 300, 250, 200, 150, 100, 50. A four-step cone and one set of back gears are to be used. Can we make it? I should say not. A little calculation will show that this is what happens:

With the open belt, 400, 350, 300, 250 revolutions per minute.

With the back gears, 200, 175, 150, 125 revolutions per minute.

To get what we want it will be necessary to have a back gear for each step on the cone, and naturally we fall back on the good old geometric progression.

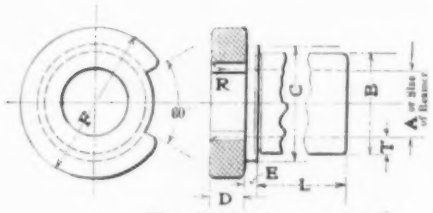
An inspection of a number of very old tools reveals that both cones are often of the same size. Where this is the case, the geometric progression follows as a matter of course; by this, if the old fellows who designed those tools were alive, they might refute the claim that Brown & Sharpe were the first to recognize the advantage of the system in question. I am not unmindful of the fact that saving of pattern work may also have had something to do with making them alike. Some of these tools have the back gears properly rated too; but here is where many, even modern tools, fall down. A milling machine of good make, and not ten years old, had a back-gear ratio of 10½:1, and pulleys so proportioned that we got the following speeds, neglecting fractions.

With the open belt, 648, 429, 289, 191 revolutions per minute.

With the back gears, 61, 40, 27, 18 revolutions per minute.

Note the drop from 191 to 61, and it may be unnecessary to mention that no extra countershaft speed could well make up for it. We changed the back gears and added a countershaft speed.

Commercially considered, it should

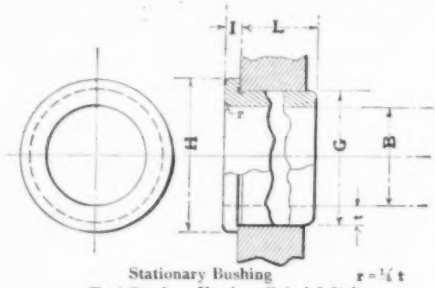


Moveable Bushing R = T
Tool Steel. Harden & Grind.

Size	Approx. Dia. of "B"	Approx. Dia. "C" & "F"	D	E
0 to 7/16	A + 1/16	A + 5/16	3/16	5/16
7/32 " 1/2	" 1/4	" 3/8	3/16	3/16
9/32 " 1/4	" 5/16	" 7/16	1/4	1/8
25/32 " 1	" 3/8	" 9/16	1/4	1/8
1 1/32 " 1 1/4	" 1/2	" 3/4	" 1 1/8	3/32	1/8
1 9/32 " 1 1/2	" 9/16	" 13/16	" 1 1/4	3/32	1/8
1 5/32 " 1 3/4	" 5/8	" 7/8	" 1 3/4	5/16	5/32
1 25/32 " 2	" 3/4	" 1	" 1 3/4	5/16	5/32
2 1/32 2 1/4	" 3/4	" 1	" 1 1/8	3/8	3/16

NOTE:
"L" will vary to suit conditions

FIG. 1

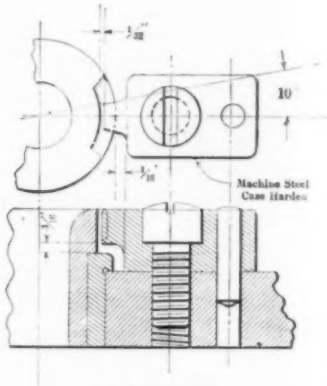


Stationary Bushing r = 1/4 t
Tool Steel. Harden, Grind & Drive.

Size	Approx. Dia. "G" & "H"	I
0 to 3/8	A + 3/8	A + 1/8	3/32
7/32 " 3/8	" 3/8	" 5/8	3/16
9/32 " 3/8	" 5/8	" 3/4	3/16
25/32 " 1	" 3/4	" 1/8	1/8
1 1/32 " 1 1/4	" 1	" 1 1/8	5/32
1 9/32 " 1 1/2	" 1 1/8	" 1 5/16	5/32
1 1/32 " 1 3/4	" 1 1/4	" 1 3/8	6/32
1 25/32 " 2	" 1 3/8	" 1 1/2	6/32
2 1/32 " 2 1/4	" 1 1/2	" 1 3/4	6/32

FIG. 2

PROPORTIONS FOR MOVABLE BUSHINGS



Stop for ½ Bushing.

NOTE:
The essential dimensions are shown, other dimensions may be made to suit conditions.

FIG. 3 Stop Adapted for the Moveable Bushing

make no difference what kind of increase is used; but it certainly is important to have only a small difference between the speeds. Upright drill presses are particular sinners in this respect. One of these machines that we consider good otherwise has the following speeds:

With the open belt 710, 396, 228, 127 revolutions per minute.

With the back gears, 129, 72, 42, 24 revolutions per minute.

This is an average of about 1.72 per cent. increase and the back-gear ratio is wrong, so that the slowest open-belt speed is nearly the same as the fastest back-geared speed. An investigation shows that the others are in about the same class.

The large speed increase in these tools is, of course, on account of the large range of work which they are supposed to handle. Nevertheless it means that when a cutter shows signs of distress at a certain speed, we cannot reduce it just a little, but must come down far more than would be necessary. I have not had a chance to measure a lathe as bad as this, but have seen some that I suspect are worse. More speeds and closer together are what we want, and in system we have no choice without a lot of extra gears.

It is my firm belief that in feeds the geometric progression is a misfortune, because as the feed is increased we are limited in selection. Suppose for instance that such a feed was applied to a planer, and it at once becomes clear that it would not be as good as the notch by notch now used. Running at 10 notches it may stand 11 but not necessarily 13; and having the 11 we can use that, with a corresponding saving. The same reasoning applies in other cases.

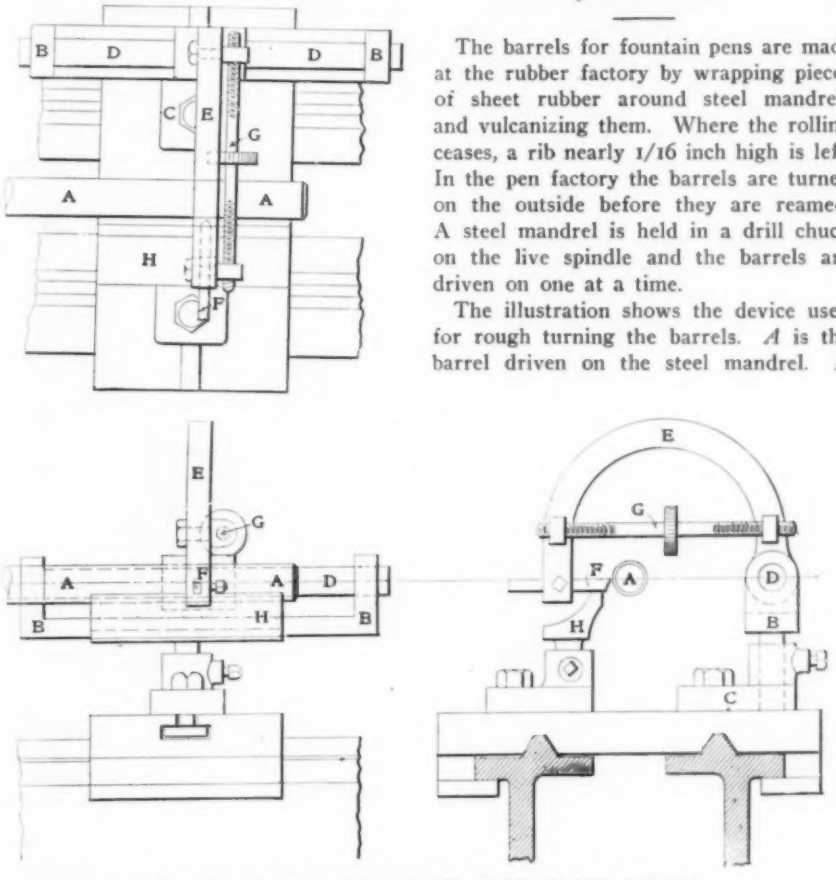
The feeds on lathes driven from the change gears, in one of those new gear boxes, adding one by one, is unquestionably the correct solution of the feed problem for those machines. I cannot see why a milling machine or any other machine should be treated differently.

H. F.

Turning Hard-rubber Fountain-pen Barrels

The barrels for fountain pens are made at the rubber factory by wrapping pieces of sheet rubber around steel mandrels and vulcanizing them. Where the rolling ceases, a rib nearly 1/16 inch high is left. In the pen factory the barrels are turned on the outside before they are reamed. A steel mandrel is held in a drill chuck on the live spindle and the barrels are driven on one at a time.

The illustration shows the device used for rough turning the barrels. *A* is the barrel driven on the steel mandrel. *B* is a yoke held in a socket *C*, which can be set so as to turn either taper or straight. *D* is a spindle on which the swinging arm *E* slides. The swinging arm *E* carries at its outboard end the tool *F* held by a set-screw. All coarse adjustments of the tool are made by tapping the tool in or out and securing it by the set-screw. Fine adjustments are made by the right- and left-hand screw *G*, which springs the swinging arm together, bringing the tool deeper into cut. The nurled wheel on *G* is graduated, but this is not shown. The tool rests on a bar *H* similar to the ordinary hand rest.



DEVICE FOR TURNING HARD-RUBBER FOUNTAIN-PEN BARRELS

The feed of the tool is by hand, and when the cut is finished the tool is swung back out of the way so that the finishing cut can be taken. The finishing cut is made with a tool similar to a carpenters' chisel about ½ inch wide. It is run once or twice across the work, taking a fine scraping cut. After the finishing cut is taken the operator grasps the barrel with a rag, the friction warms it, it expands, is easily removed from the mandrel, and a new one is driven on with a wooden mallet.

E. A. Dixie.

Limits of Accuracy in Calculations

The value of rapid and accurate calculation cannot be underestimated. In teaching mathematics at engineering schools and colleges, all that is not essential for practical use is dispensed with, and the slide rule as an assistant for rapid calculation holds a foremost place. There are, however, a few of the older generation who look on it with distrust. But their conversion or their extinction is only a matter of time. They are too methodical to permit the use of any system which seems to be a short-cut of uncertain value. Their distrust, no doubt, is caused by their ignorance of the theory of the instrument. They have not studied and show little desire to study the conditions under which it should be used.

Discussions regarding the suitability of the slide rule for general calculations may often take place with such a person. After an amount of arguing, your opponent suggests a course which, at first, appears to be a true test of the worth of the rule. He proposes that a sum be set and each is to do it his own way; for instance, to multiply 686 by 257. You use a slide rule and obtain for an answer 176,200. He rushes laboriously through lines of figures and, if he has not made a mistake, will get an answer of 176,302 which is correct. Generally he is doubtful of the accuracy of his answer and considers it advisable to run through his figures again and so avoid any possibility of mistake. A comparison of results shows the slide-rule answer to vary from the admittedly true one by 102 units. He does not consider carefully what this deviation means. He looks upon it as an error of 102 units and not in the light of a percentage. He has also been too busy to notice that you could have done half a dozen sums while you were waiting for him to finish his. The failure of your method as regards correctness is evident, and he goes away as unconvinced as ever, deploring that you should be so foolish as to use such an instrument.

Consider this apparent error from the practical and more correct standpoint. The answer given on the slide rule, as far as it could be read, differed from the true one by 102 units. This has little

meaning unless considered as 102 into 176,302, or 0.058 per cent. If the sum had contained more factors, the percentage of error might have been greater than this. It is never likely to reach above 1 per cent.

If we wish to use a method of calculating which will give results liable to an inaccuracy of, say 1 per cent., we must first examine carefully the data connected with the sum. Suppose, as is often the case in practical work, that the value of an item could not be ascertained to within 5 per cent. of its real value. What would be the use of trying to obtain an answer correct to 1 per cent. if one or more of the items might vary by 5 per cent.?

The following question, which I take out of a text-book on the steam engine, will serve to illustrate the uselessness of working out an answer to too fine a degree of accuracy. I state it briefly: Diameter of cylinder, 3 feet 6 inches; stroke, 5 feet 0 inches; cut off, one-third of the stroke; steam is admitted at 45 pounds pressure; find the work done in one stroke. The answer is given as 218,061 foot-pounds. Of the figures related to an actual case, one would feel satisfied if he were sure that the first three significant figures were correct. Who could be sure that the steam pressure in the cylinder was 45 pounds? The gage would have to be a good one to tell the pressure to a pound or two. Piston and valve leakages, condensation, etc., are not taken into account. The actual pressure behind the piston would as likely be 44 as 45 pounds. Taking it at 44 pounds would alter the result by 2.22 per cent., or by 4850 foot-pounds.

The errors which result from the use of a slide rule are small in comparison with these unavoidable variations, which result from the inability to determine correctly what goes on in actual practice. A large percentage of the calculations which draftsmen make are similar to the above case, containing, as they do, many quantities whose values cannot be obtained accurately. Sometimes it is because we know so little about the materials under consideration, as when finding the stresses in metal of different kinds and shapes. Or it often results from the inaccuracy of recording instruments.

It is always well, before making a calculation, to consider the percentage of accuracy which should be aimed at. By so doing much time which would otherwise be wasted may be saved. It is not advisable to use the slide rule for every calculation. A number of arithmetical short-cuts can be used to great advantage. If a number already written down requires multiplying by, say, 19¾, it is simple to multiply by 20 and by ¼ and subtract the results. A list of examples like this could be extended almost indefinitely.

One essential point for the quick manipulation of the slide rule is a ready knowledge of the decimal equivalents of fractional numbers from 1/16 to 15/16. They should be known by heart and not require looking up in a list.

E. M. Senyour.

M———, England.

A Milling Jig

The piece milled in this jig is a plain rectangular piece *A* in Fig. 1, of tool steel, ⅛x1x4 inches. Two of the edges and one side are milled. The edges are parallel with each other, and the flat side is parallel with the opposite side, which is not finished for its full width, but is milled with a bevel, as at *B*, Fig. 1. It is essential that the line of bevel be parallel with both the edge and the finished side; hence it should be the last operation. Formerly each one of these cuts was made a separate operation. Several jigs had been designed to do the work more quickly, but they were discarded; for in use the saving in the actual milling time was partly lost by inconvenience in adjusting and clamping the work. The jig in use at present, herein described, overcomes this objection.

Fig. 1 is a cross-section of the jig through the line 1-2 in Fig. 2. Fig. 3 is a section through 3-4 in Fig. 1. The block *A* is first placed in the jig at *C* for milling its edge, after which it is transferred to *D*, where the side is finished.

From there it goes to *E* for machining the other edge, and finally to *F*, where the bevel is milled. It is evident that all of these operations can be done at one time with one traverse of the platen, though of course on different blocks. The jig is of a length to accommodate four of the blocks for each operation, making its total capacity 16 blocks. When it is once full, every cut finishes four pieces complete.

The work is held at *C* by clamp *G* and at *E* by clamp *H*. These two clamps are connected with a bolt *I* and are drawn together between its head and nut *J*. This nut is kept from turning by a small pin which enters a hole in clamp *G*, as shown. Through the lower end of clamp *H* is a screw which bears on the end of the pin *K*. This pin has a 45-degree point which enters a countersink in the pin *L*. At the top of the pin *L* a 45-degree groove was cut, into which fits the bar *M*. This bar runs nearly the full length of the block to be milled and is held in place by a small pin at each end, which enter holes in the casting, as shown. Between these pins, under the bar *M*, is a small leaf spring (not shown) which keeps it raised from the surface of the casting. Under the pin

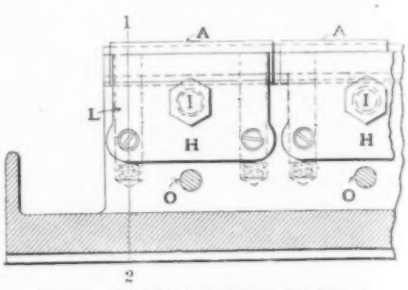


FIG. 2. SECTION THROUGH 3-4 FIG. 1

L is also a spiral spring for raising it when the pressure is relieved. There are two pins *L* for each block, as will be seen in Fig. 2. At the lower ends of the clamps *G* and *N* are screws similar to that in clamp *H*. Between these screws and running clear through the casting is rod *O*. The clamp *N* is held in position by the screw *P*. The casting is tongued to fit the milling-machine platen and has a flange running entirely around it, which forms a pan for holding the oil, whence it is returned to the original source.

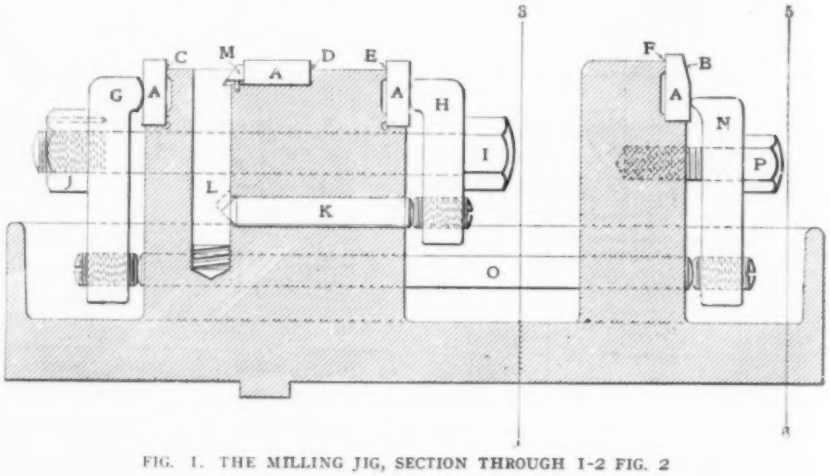


FIG. 1. THE MILLING JIG, SECTION THROUGH 1-2 FIG. 2

Fig. 2 shows the shape and arrangement of clamps *H*, and Fig. 3 that of the clamps *N*. The clamps *G* are the same shape as clamps *N*, except that the point of the latter which bears against the work is different. This was done in order to catch the work as nearly central as possible, for the top of the clamp cannot be raised as it must clear the bevel cutter. In operation, the blocks are put in place and all are clamped by tightening screw *I*; at *E* directly through the clamp *H*; at *C* through the screw *I* and clamp *G*; at *F* through the bolt *I*, clamp *G*, rod *O* and

clamp *N*; at *D* through clamp *H*, pins *K* and *L* and bar *M*.

It will be noticed that here the work is drawn down to a solid bearing on its seat, by means of the angled bar *M*. It will also be seen that when the pressure is released the springs at once relieve the tension from the work. Thus all clamping and releasing are done through one set of screws. The clamping pressure is equally distributed on all of the blocks,

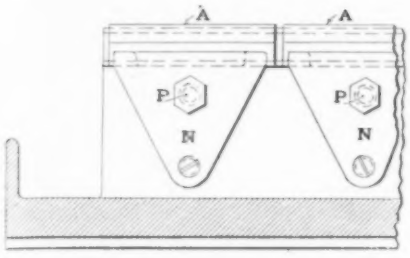


FIG. 3. SECTION THROUGH 5-6 FIG. 1

for each clamp reacts against the other. all are easily adjusted by the screws at the bottom of the clamps.

In starting on a lot of these blocks, it is necessary first to fill up the spaces *D*, *E* and *F* with other blocks (we use those which had previously been machined) until the first lot is ready for its last operation at *F*, as the jig will not clamp unless all the spaces are filled. The same holds good when finishing the last lot. By placing four extra pieces in a lot, and when through leaving four pieces in the jig in their various finished stages, it may always be kept full and will save the inconvenience of looking up stray pieces to fill in when starting. The milling is done with a wide surface mill, which finishes the blocks at *C*, *D*, and *E*, and a special mill with the required bevel.

No doubt there are many jobs to which the principle of this device could be profitably applied. It gives perfect satisfaction on the work described and clamps so firmly that stops are unnecessary, as the work does not slip. It is is an inexpensive fixture and very efficient.

L. F. BENJAMIN.

Hardening Hack-saw Blades

When we first began to make hack saws in a small way, one of our chief difficulties was to find a quick and effective method of hardening the blades without warping them all out of shape; the manner in which this was finally done was to wire them into bundles, using fine iron wire, putting twelve new blades, laid alternately, the teeth of one beside the back of the next, and so on, and an *old* blade on each side of the twelve new ones, making fourteen in each bundle.

These bundles were packed in iron cylinders and slowly brought to the proper heat and then dumped onto a big, hot iron plate and each bundle caught up in turn with special tongs and immediately quenched.

These tongs were ordinary heavy blacksmiths' fire tongs with iron cross pieces welded onto the jaws, so that when the bundle of blades was grasped, it was under pressure the whole length and was held so till thoroughly quenched. Care was taken in seizing the bundles to get the old blades, and not the teeth, next to the jaws of the tongs.

It was found by this method that the only warping was in the two outside ones, and hence the use of scrap blades. The blades were afterward drawn, but in this we found little tendency to warp.

ETHAN VIALL.

A Milling Job

Fig. 1 shows a flat stock piece, blanked out of cold-rolled stock, then placed in a perforating die and the metal removed, which leaves the rectangular slot *A*. From the perforating die the pieces go to the drop hammer where they are planished. They are then placed one at a time in a jig which locates them by the slot *A*, and the trunnions are hollow-milled, a sensitive drill being used for this operation. After the trunnions are milled the pieces are brought to the milling machines to have the edges formed, and here is where most of the trouble originated in getting the pieces finished properly.

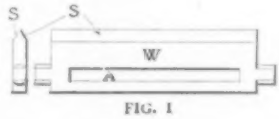


FIG. 1

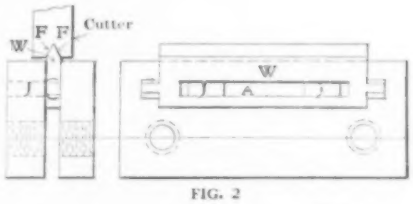


FIG. 2

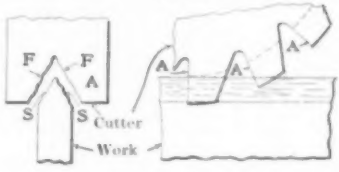


FIG. 3

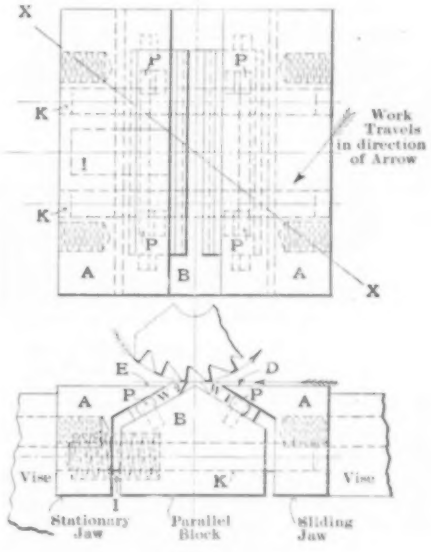


FIG. 4

A MILLING JOB

Carbon steel was used for the cutters, and while they were new and kept sharp they gave a very good finish to the faces *S S*, Fig. 1, of the work *W*. After the cutters had been sharpened so many times that the cutting edges were close to the heels, they would not stay sharp for more than 20 or 30 pieces, when they would have a rough surface at *S S*. In speaking of the cutters as they, two are meant, as I had to use both eventually, one for roughing and the other to give a finish to the pieces by removing 0.010 inch metal left by the first cutter. This increased the time on the work to nearly double that necessary when only one cut was required.

I had been using high-speed end mills on cast-iron work to great advantage, so thought the high-speed cutters would be just what I needed to get the cold-rolled pieces out. Thinking that the high-speed cutters would save time on each lot, two cutters were ordered and their arrival impatiently awaited. When they did arrive, I had an order waiting to be filled, so no time was lost getting the new cutters to work. Here is where we intended to cut the time in half, but didn't. It took longer to finish that order than any previous one, owing to the fact that I could not get a smooth surface any way I tried, and I could not see for some time the reason why.

When I had taken the first of the new cutters off the arbor and tried the second one, getting practically the same results, I was a little bit surprised to find that neither one would make a smooth cut. A further investigation showed why these cutters made such a rough cut.

As is well known, the high degree of heat required to prepare the high-speed tools for the hardening bath leaves a rough surface on them, which makes them unfit for fine finishing where the cutting edge cannot be ground or stoned. As the V-groove could not be polished, the cutting edges were like the exaggerated outline shown at *F F*, Fig. 3. It will readily be seen that the formed edge milled by a cutter in this condition would be similar to that shown at *S S*, Fig. 3. I had both of the high-speed cutters ground on the faces *A A A*, Fig. 3, thinking that by using a fine emery wheel I could get the corners sharp enough to

make a smooth cut. While the corners were sharp, they were not even, and of course I got the same results.

Using the high-speed cutters to rough the work, I put the old cutters back on the arbor and took a 0.010-inch finishing cut. The pieces were clamped in a pair of vise jaws as shown at Fig. 2, the studs *J J* being driven into the stationary jaw to allow the work to be slipped onto them, thus locating the pieces by the slot *A*. While jaws of this kind are handy to operate and cheap at first cost, the setting of the work so that the cut will be parallel with the insides of the piece requires some experience to get it right.

The trouble I had with the new cutters caused me to study up some means of either using them or getting the work out in such a way that the loss of these special high-speed cutters for this work would not be felt. I decided to have a new pair of vise jaws made as shown at Fig. 4. By using these jaws the work *W W* can be placed two pieces at a time, one on either side of the block *B*, locating each piece by slipping the slot *A* over the studs *P P* as formerly on *J J*, Fig. 2. The sliding jaw is then brought forward, bringing the overhanging part *D* onto the work W_1, clamping it down onto the block *B*. The sliding jaw is then brought farther forward, pushing the block *B* with the work *W* 2 against the stationary jaw at *E*, thus clamping both pieces of work at the proper angle onto the block *B*. The work is thus passed under the cutter at an angle of about 45 degrees to the center of the arbor, as shown by the line *X X*.

By cutting across the work at an angle, there is less chance for chattering and the length of cut is shortened. Two faces are milled at once, thus getting the same amount of work done in less time than when one piece at a time was milled by the formed cutters. An ordinary cutter, 2 inches long by 2 inches diameter can be used and does not get dull as soon. In setting the job up, the pieces are placed in the vise as easily as in the old ones. When the vise is clamped in place and the table is raised so that the first cut comes about the center of the thickness of the pieces *W* 1 and *W* 2, they are taken out and turned end for end, under side up, then the second cut taken. This will will make both sides alike and, by raising or lowering the platen, the distance from the apex of the formed edge to the bottom edge of the pieces can very easily be brought to and kept within 0.001 inch of the required distance.

A glance at Fig. 4 will show that the front and back jaws are guided by two 5/16-inch dowel pins driven in and extending on either side of the block *B*. In the stationary jaw a flat-bottomed hole *I* is drilled and the block *B* has one drilled opposite to receive a spring which pushes the block *B* away from the stationary jaw when the vise is opened and the sliding jaw drawn back. The vise requires to be opened about 1¼ inches to allow the work to be placed in or taken out.

Formerly the time required to finish an order of 500 pieces averaged about 70 hours; as it was required to have the edges as smooth as possible, the work was not hurried and two cuts were taken. With the new jaws and a spiral cutter 500 pieces can be finished in 20 hours. When using the old jaws, Fig. 2, care was required to keep the chips away from between the sides of the jaws and the work, or the cut would not be parallel to the sides of the work. In using the new jaws care is necessary to insure the pieces lying down on the block *B*. Otherwise the work will not be right. The block and jaws of this kind should be carbonized, and the working surfaces ground to a fit.

J. MILLER.

Pattern for Truck Wheel with Staggered Spokes

The accompanying illustrations show the manner in which a truck wheel 21 inches diameter by 2 inches face was recently fitted up for pattern and flasks, the wheel having ten staggered wrought-iron spokes, each spoke being spread 5/16 inch from a perpendicular at the hub.

One-half only of the pattern was made. The rim *A* and the hub *C* were turned and placed on a mold board accurately with relation to center lines, and special care was taken to make the board of several pieces, with battens beneath to insure its holding its shape in use.

The spaces included by *L* and *M* are ten in number and alternately raised and depressed 5/16 inch from the plane surface of the board at the hub, beginning with the level of the mold board at each interval at the rim. The edges of these elevations and depressions must have plenty of draft and be exact counterparts of each other, so that the cope and nowel will fit on the center line of the spokes when placed together.

The prints *B* for the spokes are also ten in number, and lie central on *L* and *M*, being one-half circles in section, of a diameter the same as the wrought-iron spokes which are placed later in the mold, connecting the rim *A* with the hub *C*. The raised places *D* on the rim are to allow sufficient metal to hold the spokes, and *K* represents the core print on the hub, while *J J* are two runners placed on the board to allow the flow of metal between the rim and hub, which will readily be seen to be entirely disconnected otherwise, so far as the flow of metal is concerned. The runners are ⅛ inch thick where they join the rim and triangular in shape at the hub, having about the same area on each end. The swelled places on these are to accommodate the end of the plug when the flask is rammed to make the pouring holes.

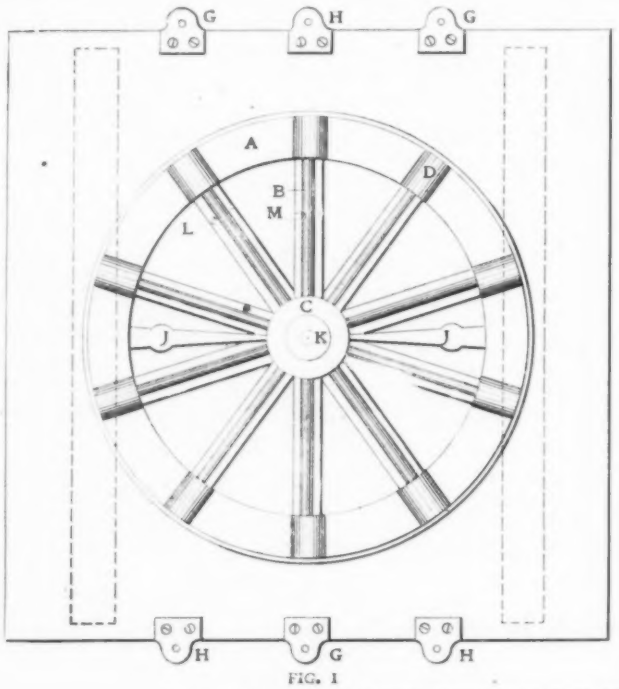


FIG. 1

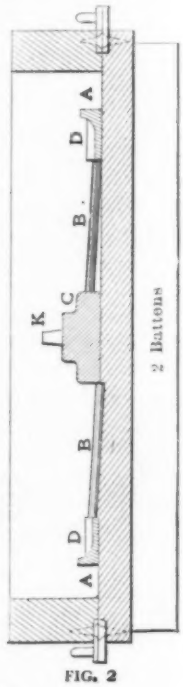


FIG. 2

PATTERN FOR TRUCK WHEEL WITH STAGGERED SPOKES

Fig. 1 shows the flasks removed, Fig. 2 in position. Four complete flasks were made for this particular job, the four copes and four nowels being interchangeable with one another and also with the mold board itself. The three dowel plates *G G G* are those having the holes. These were first placed on the board and all the flasks parts bearing pins were next fitted to them. The plates with pins *H H H* were next put on the mold board and all the flask parts having holes in the plates fitted as before. It seems hardly neces-

sary to say that the dowel plates on the mold board must be spaced with accuracy one from another, and at an exact distance from the pattern on both sides; otherwise the molds will never fit.

JOHN M. RICHARDSON.

Making Split Rings

I once had the job of making one thousand of the small rings shown in Fig. 3. These rings were composed of a little less than two coils of 16-gage brass wire. It was necessary that the coils lie so close together that they would pinch a piece of thin paper at any point between them; also that they lie flat, that is, the coils must not be of spiral form, but have the two sharp bends *A*, Fig. 3, in the center of the piece from which the completed ring was formed.

After trying several methods I finally hit upon the idea of coiling the stock into a spring of the required diameter and cutting it into pieces, with a little less than two coils of the spring in each piece. I made a die like Fig. 5, in which *B* is a hole of two different diameters, shown by the dotted lines *C* and *D*. The part *C* is the size of the outside of the rings, and *D* is the same diameter as the inside. I turned a punch, Fig. 4, from a piece of round steel, so that it would fit down into the die. Then I put one of the pieces that I had cut from the spring into the die so that it rested on the shoulder at *E*, placed the punch so that the shoulder *F* rested on the top of the piece, and struck the punch a sharp blow with a hammer. On taking the piece out of the die I had a fair representation of the article wanted, except that the coils lay apart nearly half the thickness of the wire. However, this was overcome by coiling a spring with considerable initial tension.

Cutting the pieces off the spring with a chisel was very unsatisfactory, being slow, inaccurate, and leaving the ends in bad shape. I made the device shown in Figs. 1 and 2 as an improvement. In operation the end of the spring is placed over the lower shear *G* with the end of the coil agains the pin, or stop, *H*. This stop is placed the thickness of the wire back from the cutting edge, and to one side, the amount that it is required the piece be less than two coils. While the spring is held in the proper position with one hand, the lever *J* is pulled down with the other, causing the two shears *G* and *I* to pass each other, thus cutting off the piece. The plunger *K* was made the proper length to strike the bottom of the hole in which it fits before the shears could pass each other enough to damage the cutting edge of *G*, and the spring *L* was made strong enough to hold up the lever *J*.

It took only about two days to make the rings after the fixtures were ready, and a fair profit was made on a job that looked like a loss.

T. DE WITT.

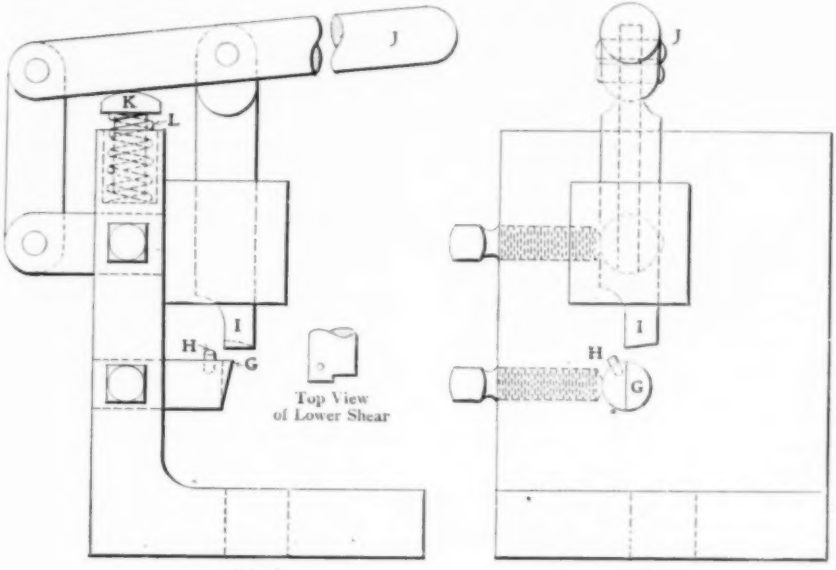


FIG. 1

FIG. 2

FIG. 3

FIG. 4

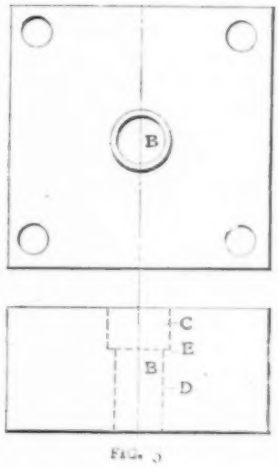
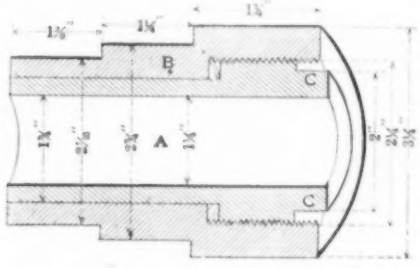


FIG. 5

MAKING SPLIT RINGS

Turning and Boring Pulleys with Light Arms

Having to turn and bore a number of small pulleys that were very light, many were broken on account of the frailness of the arms, which were cast so thin that the pressure of the drill would break them. I got tired of being called down about it and got permission to make a bushing for the chuck to prevent the trouble.



BUSHING TO PREVENT PULLEY ARMS BREAKING

The body of the bushing is of cast iron and is turned slightly tapered to fit the bore of the chuck, which is 3¼ inches and 2¾ inches. The end that is turned 2 7/16 inches fits the hole in the spindle, which is bored the full length, the bore of the chucks and spindle being the same as the outside face of *B*. *B* is bored 1¾ inches, counterbored 2¼ inches in diameter and 1½ inches deep and has 12 threads to the inch. The inside bushing *A* is bored 1¼ inches and is turned to a loose fit so it can be turned by hand. The end at *C C* is nurled.

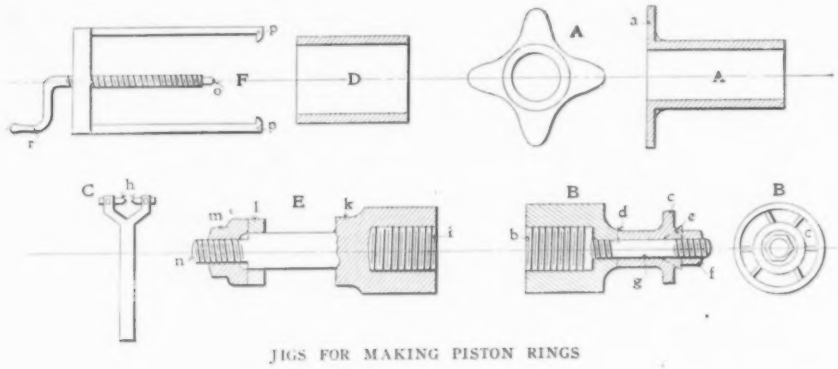
The bushing *A* is adjusted so that the hub of the pulley rests against it and relieves the arms of the strain. It can be adjusted to different length hubs, as it has an adjustment of a half inch.

I have chucked 600 pulleys since I made this bushing, and of the lot only two have been scrapped.

H. JAMES.

Jigs for Making Eccentric Piston Rings

A is the usual cast-iron piece with four wings which are drilled and tapped for fixing it on to the face plate by cap screws from the back. The end with the lugs is first faced off square with the body. This piece is turned and bored, making allowances for the piece which is to be cut out of the rings for the required spring, and also for the amount to be turned off to make the thin side on the ring. The rings are then parted off, leaving them about 1/64 inch wider than finished size. They are then put on jig *B*, which is of cast iron, threaded at *b* to suit the lathe spindle. At *C* it is turned to fit the inside of rough ring and split from *d* right through *C*. *E* is a tapered collar and *F* is the nut which presses the collar into this spring chuck. *G* is a stud, one end of which fits the nut *F*. The other end is screwed into the body *B*, as shown, and riveted. After a ring has been fixed on to this spring chuck it is faced to size with the tool *C*, *H H* being the cutting tools. After the rings are faced to size, the required amount is slit out of them in the milling machine. The sleeve *D* is then bored to allow the rings to just fit in when the ends are pressed together close. It is made long enough to hold as many rings as will be safe in the next operation and leave them ¼ inch over at each end. Eight rings, 4 inches diameter, ⅜ inch wide, are enough.



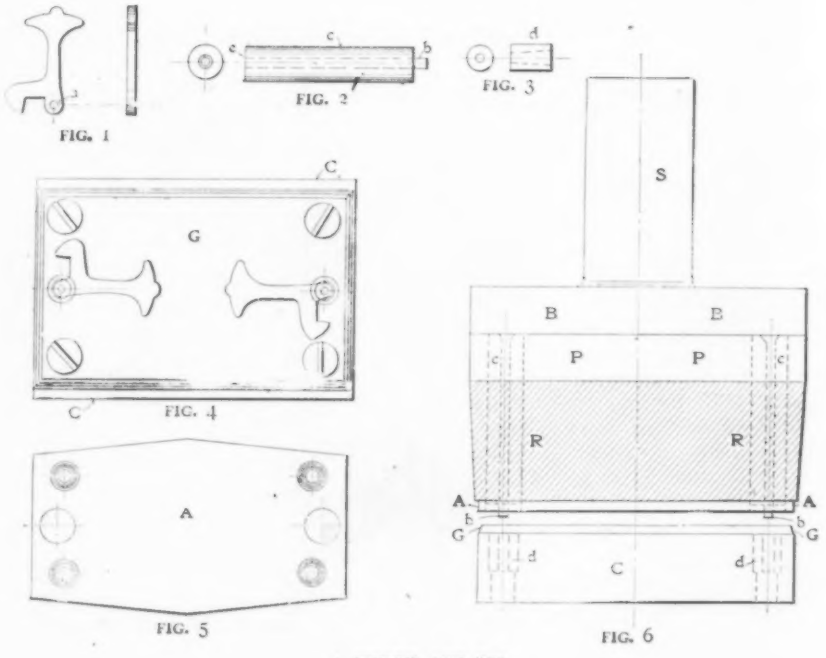
JIGS FOR MAKING PISTON RINGS

E is then made with end *I* threaded to fit the lathe spindle, and the other end turned with enough eccentricity to give the required thick and thin side to the rings. The part *k* and the collar *l* are turned a snug sliding fit for the sleeve *D*; a mark should be placed on *k* at the highest part of the eccentric, so that the slits in the rings will always be placed there, and care must be taken in putting the rings into the sleeve, to see that the slits are all in line. When the sleeve is loaded, one end is placed over *K* with the slits in the rings opposite the mark; the collar *l* is then put in place and the whole tightened up with the nut *m*, which is threaded 11½ to the inch to suit the screw *n*, which is threaded the pipe-thread standard. The sleeve *D* is then removed with the jack *f*, the screw *o* is unscrewed to the end, the two points *P P* are slipped over the sleeve, the point of the screw *o* is put on the center of the screw *n*, the handle *r* is held fast, and the lathe started up. Finally the rings are turned to size.

GEO. SCOTT.

A Punch and Die

In the punch and die shown in the illustrations the essentials, efficiency, small first and repair costs, are combined. At *a* Fig. 1, is shown the hole to be punched. In Fig. 2 *b* and *c* are punch and holder respectively. Fig. 3 shows the die bushing *d*. Fig. 6 is an elevation of the punch and die in position for operation; *S* is the shank; *B*, the body; *P*, the punch-holder plate; *c*, the punch holder; *R*, the rubber stripper; *b*, the punch; *A*, the contact plate; *G*, the guide plate; *C*, the die block containing the die bushings *d d*. Fig 4 is a plan view of the guide plate *G* and the die block *C*, and Fig. 5 shows a plan view of the contact plate *A*.



A PUNCH AND DIE

All parts are made from mild steel and cast iron except the punch *b* and the holder *c*, which are made from drill rod and kept in stock for repairs.

It will be noticed that at *e*, Fig. 2, the punch is upset and the holder countersunk to give large surface for resisting the impact when punching.

A. B. CHRISTMAN.

Making Dies for Plastic Materia

How little is understood by the average mechanic about making dies for plastic material, such as hard rubber, celluloid and allied compositions, is shown by Dixie's article on page 415. It is indeed surprising to read the views and opinions expressed by our friend, and, although Dixie's contributions are usually valuable and to the point, it shows conclusively that he has never been on the job of making molds and dies for plastic material. The fact is that no toolmaker nor machinist, let him be an expert, all-round man, can undertake to make successfully any such die on the first trial without ample instructions, pointers and continual close supervision. I have had varied experiences in this line and have never been able to find a mechanic, no matter how good in all other branches, who was an exception to this rule.

To begin, a die is almost always made first and not a male nor hub; and that for excellent reasons, which Dixie does not know, namely: Almost all articles made of hard rubber or composition have on their surface some figures, lettering, scrolls, arabesques, trade marks, etc. These designs are always in *haut relief* or raised above the surface. In making a hub it would be required for the engraver to cut the stock away all around these let-

ters and figures to get them raised on the hub, this hub being an exact duplicate of the finished article. Now it is far easier and less expensive to make a die or female, for the reason that the contour can be turned or milled, when the letters or designs can easily be engraved below this surface, making use of steel letter stamps and punches of different shapes; beads, nurls, etc., are also produced in the die in the same manner, finishing off by hand the sharp corners and polishing afterward. How much easier and quicker than cutting a hub! This master die is always made of tool steel and, after being hardened, the impression is highly polished; in fact, this polishing must be so as not to show any marks from the tool or scratches under the glass, and must be perfect.

Frames or collars to strengthen the die while under pressure are never shrunk on, for the reason that where many dies are made, this would require one collar for each die, which is useless and a waste of material, increasing the cost for each die. Instead of this the following process is used: When a die blank is turned up, milled or planed, its outside dimensions are made to some standard size. Several of these standard sizes are generally established and there are on hand in the shop several frames or collars whose inside dimensions correspond to these standard sizes.

These frames or collars are constructed as follows: A tool-steel inside collar is made and tempered, the walls of which are about 1½ inches thick; outside of this collar a solid machinery-steel ring is shrunk, with walls about 3 inches thick and of the same hight as the tool-steel collar. The die blank is always made less in hight than this frame, usually about 1 inch, to allow a locating guide for the hub which is to be made. The next step is to make the hub. This is also made of tool steel and the amount of "squeezes," as Dixie calls them, depends on several conditions: area and depth of impressions, nature of engraved figures, etc. Sometimes 15 to 20 applications under hydraulic pressure are required with from 50 to 200 tons pressure. After a perfect reproduction of the die is obtained on the hub, with all outlines bold, clear and sharp, the hub is polished in a similar manner as the die, tempered and is then ready for use. The master die is stored away for future use in case of accident to the hub.

The impressions to be used in the mold are now turned or formed. Sometimes the contour to be hubbed is made similar to the master die; in some cases no material is removed for the entrance of the hub, notably when the hub has figures or irregular surfaces on the sides, as this will produce a shearing effect which must be avoided under all circumstances. The outside dimensions are made to correspond to the nearest standard frame or collar, a neat sliding fit; at the bottom, which rests on the table of the press, a taper of 10 degrees included angle is made to one-third of the total hight of the blank. This taper allows the metal room to flow under pressure and the metal fills the former space, it being impossible to obtain results without this precaution.

After the first application of pressure, the blank, which is now tightly held in the frame, is driven out from the bottom and again brought to its first original size, including the taper which has disappeared after the pressure; this process is repeated until a perfect impression has been obtained in the die blank, sometimes as stated before, 15 or 20 times. The die is now reduced outside to the dimensions required to fit the mold. Top and bottom dies are treated in the same manner, except when the article to be made is hollow, in which case one of them becomes a male or "force." The first application of the hydraulic pressure must be very light and slow, to avoid cracks in the metal. The dies and forces are now provided with cutting-off edges and, after having been hardened, are ready to be secured in the mold and finally polished.

Sometimes when an article to be made has projections or recesses on the sides it becomes necessary to make a three- or four-part mold with loose split parts or bars, which fit in recesses in the mold. Such dies are sometimes very complicated and expensive. Extreme care must be taken that top and bottom impressions match and line up in their die blocks, and the determination of the cut-off line is a very important matter; in fact, error in judgment on this point is sure to result in failure on the part of the mold to produce a perfect article. In making the complete mold several other factors must be taken into consideration, the number of impressions in the mold, the method of extracting the molded or pressed article, without damaging it, the amount of metal in the mold to allow quick or slow heating and cooling off, as may be required, and various other details, as the room for overflow, of stock and ways of checking excess overflow, etc. The complete process of making molds for plastic material is a very interesting subject of which, as said before, not many mechanics have an intimate knowledge. It requires skill and good judgment of no mean degree, and expert workmen in this line are very scarce, the process being not as simple and easy as Dixie seems to think.

This case is somewhat similar, as has been often experienced by me and no doubt by others. An automatic or complicated machine having broken down, the super or the old man would come to have a look at it and say: "Oh, well, yes; all you have to do is to put a new screw in here, or a little patch there, or file a little off somewhere, and it will be all right; 15 or 20 minutes' work will do it." Sometimes a week would not see that machine going again.

L. C. F. GEORGE.

Making Sub-press Dies

I wish to add a little to Mr. Brickner's article on page 487.

I would suggest that after the housing has been bored a splining tool be placed in the tool post. By moving the carriage of the lathe back and forth, the grooves can be accurately cut the same depth their entire length and true with the bore, providing, of course, that they are cut at the same setting that the housing is bored. The plunger can be grooved in the lathe in the same manner. It is more essential that the grooves be absolutely parallel in the plunger than in the housing, as they guide the plunger.

When babbitting a sub-press die, it is good practice to wait until just before quitting time at night to do the pouring, so that the babbitt can cool without the vibration of the shop caused by machinery running. Under no consideration should the plunger be removed while the babbitt is warm. There is a strain set up when the babbitt is cooling, and if the plunger is left in place until thoroughly cool, the plunger will fit nicely; while on the other hand if the plunger is removed while the babbitt is quite warm, there is nothing to prevent the babbitt flowing along the line of least resistance, and considerable difficulty will be experienced in entering the plunger. I agree fully with Mr. Brickner as regards the habit of scraping the babbitt. The bearing should not be scraped; if the bearing is poor on the first pour, try it again, but do not scrape.

F. E. SHAILOR.

A very handy thing to have on the bench where there is much work to lay out on castings or sheet iron, is a solution made of chalk, glue and water. Take a pint can and powder enough chalk to fill it two-thirds full, then fill it almost full of clean, hot water and add about two tablespoonfuls of liquid glue and mix thoroughly while it is hot. This is much more handy than chalk, as you can put it on with a brush the same as paint. It will not rub off in handling and gives a nice surface to work on. The chalk must be powdered very fine or it will be rough when dry.—*Boiler Maker.*

They are discussing in England the compulsory use on automobiles of automatic controllers to prevent a machine from running above a maximum speed on public roads under any conditions. There is said to be no difficulty in furnishing the device.

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Education and the Man

Led by the example of the presidential address of James M. Dodge before the American Society of Mechanical Engineers two or three years ago there has been a good deal of discussion of the value of education of late in which the attempt has been made to measure that value in figures by comparing the earnings of those who have and those who have not had educational advantages. All of these articles, so far as we have seen—and some of them have found their way into our columns—claim to prove by an overwhelming array of figures the productive value of the education of the schools. There is, however, a line of counter argument which has not found its way into print to any extent, which puts forth the idea that these parallel column exhibits are based upon an essential fallacy in that educated men are necessarily picked men whose average income or achievements cannot fairly be compared with their unpicked contemporaries. The idea is that it is only the boy who is above the average who cares for higher education or who would, in general, be selected for it by his parents, or indeed who could successfully prosecute it even if he were selected. Carrying the argument a little further, it goes on to say that the educated men, had they received no education, must necessarily have gravitated upward, secured superior earnings and accomplished greater results than others. The argument admits that these superior men may have been assisted by their educational attainments and have earned more and accomplished more with education than they would have done without it, but this is not the comparison of which so much is being made. The argument asserts that a comparison of educated and uneducated men of equal initial ability is the only fair one, but it is not, nor indeed, can it be made. Such a comparison, were it possible, will be seen to be entirely different from the one which is actually made in which a superior class of educated men is compared with the average class of all that remain.

Closely related to this are the standing examples of men who, without educational advantages, have risen high in the industrial and even in the scientific world. The pro-educational method of disposing of these cases is to assume that in spite of the achievements which such men have accomplished, they could and would have done much more had they had educational advantages—a statement which begs the entire question by assuming to be true the very thing that is to be proven.

We have long thought that the educational argument ignores certain differences in men. As we look at it mankind may be properly separated into three classes. At the bottom are those, and there are many, to whom education, as that term is commonly understood, for it is in its common acceptance as school education as schools now exist that we use the term, would be of the slightest advantage. There is no dodging the fact that large numbers of men are fundamentally incapable of serious or productive mental effort—a fact which is commonly recognized by the saying that in certain cases, good bricklayers, for example, have been spoiled in making poor lawyers or doctors, as well as by the companion statement that the attempt to educate certain men is equivalent to an attempt to make bricks without straw.

Above these men comes another class to whom education is of the first order of importance—men who are intrinsically superior to the first class and who without education would undoubtedly surpass them, but who with it surpass them much more. Such men supply the general run of our doctors, our lawyers and our engineers, but they do not include our geniuses.

Above this class comes a third—small in numbers but nevertheless a prime and perhaps the leading factor in the progress of the world. Such men, we believe, are largely independent of the education of the schools by being superior to it. Two cases of this kind occur to us. The first is John Fritz—a man to whom metallurgical engineers everywhere doff their hats, and the second is Fred. E. Ives, inventor of the half-tone engraving process and of other photographic and optical inventions of which a list would make a catalog.

Contrasting the achievements of these men with the attainments of the average college professor, it seems absurd to us to suppose that they could have obtained very much from the education provided by such professors. Mr. Ives began life as a photographer and almost simultaneously began experimenting and inventing. Of an entire college curriculum but little could by any possibility have been of use to him in his later work. What he needed was optics and the related branches of physics, and this he absorbed as a sponge absorbs water. Looked at from the standpoint of a specialist, what we call higher education is, in reality, not much more than elementary education. The ground covered in a college course is so extensive that no subject can be gone into deeply. What Mr. Ives required was not the skimming of many subjects, but a profound knowledge of one. To us it seems little more than absurd to suppose that the usual college course taken in its entirety would have been of any considerable use to him or, indeed, much more than a tiresome slaving over many subjects of very little interest to him, and, meanwhile, the pursuit of such subjects would have consumed just the time which should have been put upon the few subjects of immediate application to his future work.

It is easy to say, in standard phrase,

that he would have been a better rounded man with a wider education, but that again begs the question. The argument of which so much has been made of late ignores the man and bases its claims on results, and the question is, would Mr. Ives have accomplished more with formal education than he has without it? We think not.

All this is not intended to voice a word against the claims of education in which we believe as heartily as any, but to point out that the usual view of it and especially the view which has lately been made prominent, is a very one-sided one which omits from consideration many essential elements.

The November Meeting of the American Society of Mechanical Engineers

The American Society of Mechanical Engineers will hold its next regular monthly meeting on Tuesday evening, November 12, at 8:15 o'clock, in the building of the Engineering Societies, 29 West 39th street, New York.

The principal address will be made by Charles R. Pratt and will treat of features of construction and operation of the gearless traction electric elevator, which is being installed in the Singer and Metropolitan Life, New York's two highest buildings. The paper will be discussed by engineers and architects from New York, Philadelphia and Chicago. It is expected that the subject will be very exhaustively treated from the view of the architect and the engineer. The members of all professions are cordially invited to attend.

National Machine Tool Builders' Convention

The sixth annual convention of this association was held at the Hotel Imperial, New York City, October 15 and 16, the first session opening Tuesday morning with President E. M. Woodward in the chair. At this session the president's address was read and then routine business was attended to.

The President's Address

In his address Mr. Woodward said in part:

"The hand of time on our fiscal dial points to the fact that another year has passed, and warns us that we are largely responsible for the betterment, or otherwise, of the social and business relations with each other and of the condition of our association. Machine tool builders of the United States have been benefited in many ways by the existence of this organization, and I believe that through its influence still greater benefits will be derived. Much interest is now centered on cost systems, contracts with apprentices and diplomas for apprentices. Our Committee on Apprenticeship and Diplomas has done good work, and I believe is about to make a final report. Our Committee on Responsibilities of Foundrymen has a great work to perform, and with the united support from each member of this association I believe its efforts will be crowned with success, beneficial to all of us.

"We have had an era of prosperity, the longest ever witnessed in this country, and this prosperity has been in the extreme to such an extent that we have been overloaded with orders, and have strenuously endeavored to execute them. The large and increased amount of business done throughout the United States has necessarily made large demands on capital, and consequently made the interest rate for money high. When money is high the business world commences to curtail, and a curtailment in business, particularly in the manufacturing interests, means depression.

"The present business conditions in this country seem to me to be peculiar. Our country is in a good condition. In most sections our grain crop is good and brings good prices. There is a demand for more railroads and ships to carry our products. What railroads we have are short of rolling stock, and have been unable to promptly convey our products, all of which indicate that there is a necessity for more machinery. It seems to me that the amount of money we have in circulation in the United States is insufficient for the large volume of business we handle. If we are to have a depression in our machine tool manufacturing I think that it is wise that we should heed the warning cry sent out by our secretary, 'In time of peace prepare for war.'

"Our association has stood for a great deal, and should now stand for the protection of each member in sustaining the present prices for machine tools. The reduction from our present prices will not create a demand. No more machine tools will be sold because the prices have been reduced. If our product is to be reduced in quantity, it is necessary that the present prices should be sustained in order that our loss and gain account on the ledger show a balance on the right side.

"The membership at the close of the semi-annual convention held May 14 and 15, 1907, was 76; admitted since, 6; total 81. The financial condition of this association is good."

Uniform Cost Accounting System

In connection with this topic, which also formed an important subject of discussion at the spring convention of the association, the work of the committee which has the investigation of the problem in hand was brought before the convention by the chairman, F. A. Geier. Some discussion of uniform cost systems was brought out at the Wednesday morning session, and a resolution was presented and adopted authorizing the employment of an expert to visit the plants of the various members of the association and discuss with each one the methods at present employed by him in handling costs, the idea being that by this means different systems employed at present may be harmonized to a great extent and some definite recommendation made to the committee who can then bring the matter before the association for action at a future meeting. It is the hope of the committee to be able to present a system for general adoption by the members, that will show definitely just what machine tools cost to build.

A resolution was also passed at the Wednesday afternoon session to appoint a committee to outline a uniform form of contract for selling machine tools. This committee will submit a report to the next convention.

Apprenticeship

In the account of the spring meeting of this association, at page 745, Part 1, we published the report of the committee on apprenticeship systems, which committee is headed by E. P. Bullard, Jr., and since then (at page 833) we have presented an account of the special apprenticeship system which in addition to a system of regular apprenticeship is recommended by the committee for adoption by members of the association. It is unnecessary therefore to reprint at this time the report of this committee as accepted by the organization at that convention. It should be stated that this report was drawn up after due consideration of data obtained from about one hundred different firms in the machine business and the special apprenticeship system has been thoroughly and satisfactorily tried out at the Bullard shops during the past two years.

The form of contract given in the report is to be adopted by the members of the association, though it is understood that some slight modification may be necessary in certain States and localities. Also a suitable diploma is to be engraved to be given to apprentices upon the satisfactory completion of their apprenticeship.

While the minimum wages to be paid and the minimum age at which a boy shall start his apprenticeship are given in the report, it is not expected that each and every member is to conform exactly to these schedules. Local conditions, it is realized, must enter into the determination of proper wage scales, etc.; the details covering such matters in the report represent, however, good average practice and what is expected to be suitable in the majority of cases. Where deviation from the contracts prescribed is made by any member the modification is to be submitted to the executive committee of the association for their consideration before

(Continued on Page 607)

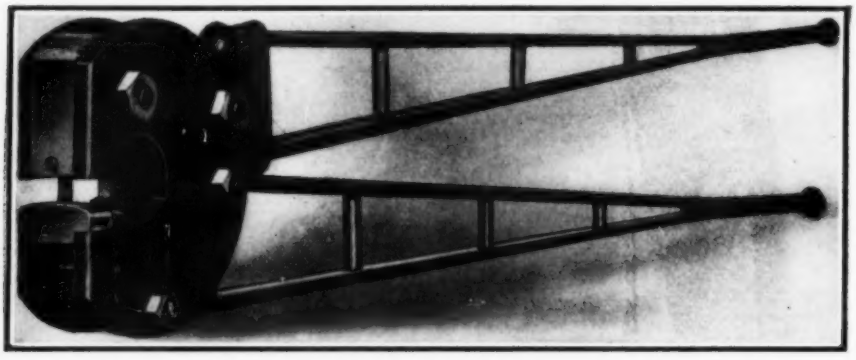
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A Lever Punch

The illustration shows a portable lever punch capable of punching a ¼-inch hole through ¼-inch stock.



A LEVER PUNCH

The handles, of the truss pattern, are made of half-round steel. The entire tool weighs 16 pounds. It can be clamped in a bench vise when it is desired to have it stationary. This tool is made by the Armstrong-Blum Manufacturing Company, 104-124 N. Francisco avenue, Chicago, Illinois.

A Geared-feed 18-inch Engine Lathe

The half-tones show two styles of 18-inch engine lathes of new design. Fig. 1 shows a lathe built for regular conditions. It has a five-step cone pulley, the largest diameter of which is 12 inches, for 2¾-inch belt. Fig. 2 shows a lathe designed to use high-speed steel tools. In this lathe the cone pulley has four steps, the largest of which is 14 inches diameter for 3¼-inch belt. With this cone the back gears are made correspondingly large in diameter and wide of face.

The spindles of both are of crucible steel with a 1¼-inch hole. The spindle boxes are of cast iron lined with babbitt metal.

The lathes are regularly supplied with compound rests, but plain rests can be substituted if ordered. Taper attachments can be furnished with either style of rest.

The feed device is new, giving eight changes without changing gears; it is shown in Fig. 3. The feed stud carries a gear at *a* inside the head, which drives the gear *d* through the two gears *b* and *c* hung on the arm depending from the bridge in the head. The gear *d* in turn drives the gear *e*. The gear *e* is provided with a clutch face to engage with the sliding gear *f*. When it is engaged with *f* it drives the gear *g*, which rotates a sliding shaft, upon which is mounted a bank of four gears *k*, any one of which can drive the clutch gear on the rod, through the intermediate gear *l*, thus providing four feeds. The gear *m* on the same shaft as the gear *d* drives the gear *n*, which is also provided with a clutch face for engaging the sliding gear *f*. When it is so engaged, the gear *g* drives the sliding

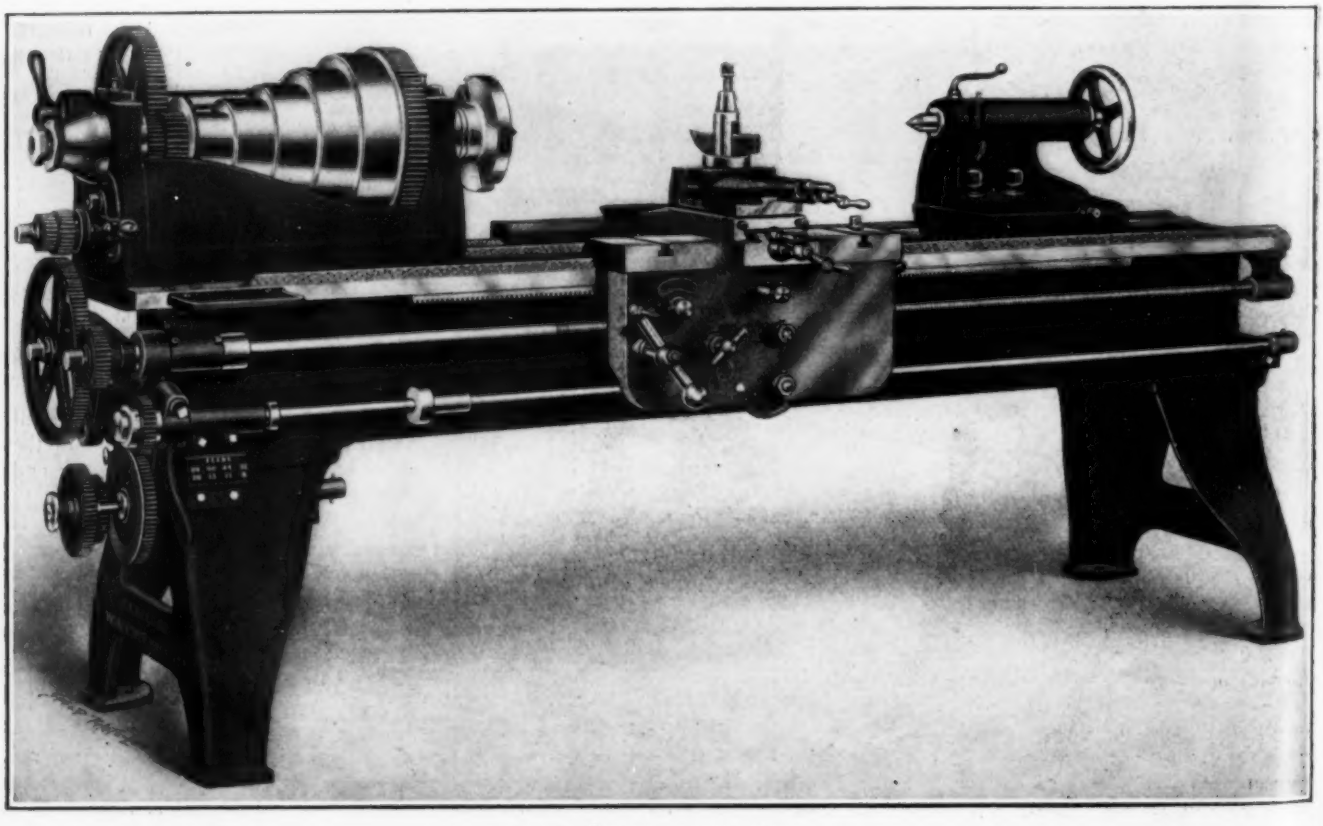


FIG. 1. 18-INCH ENGINE LATHE

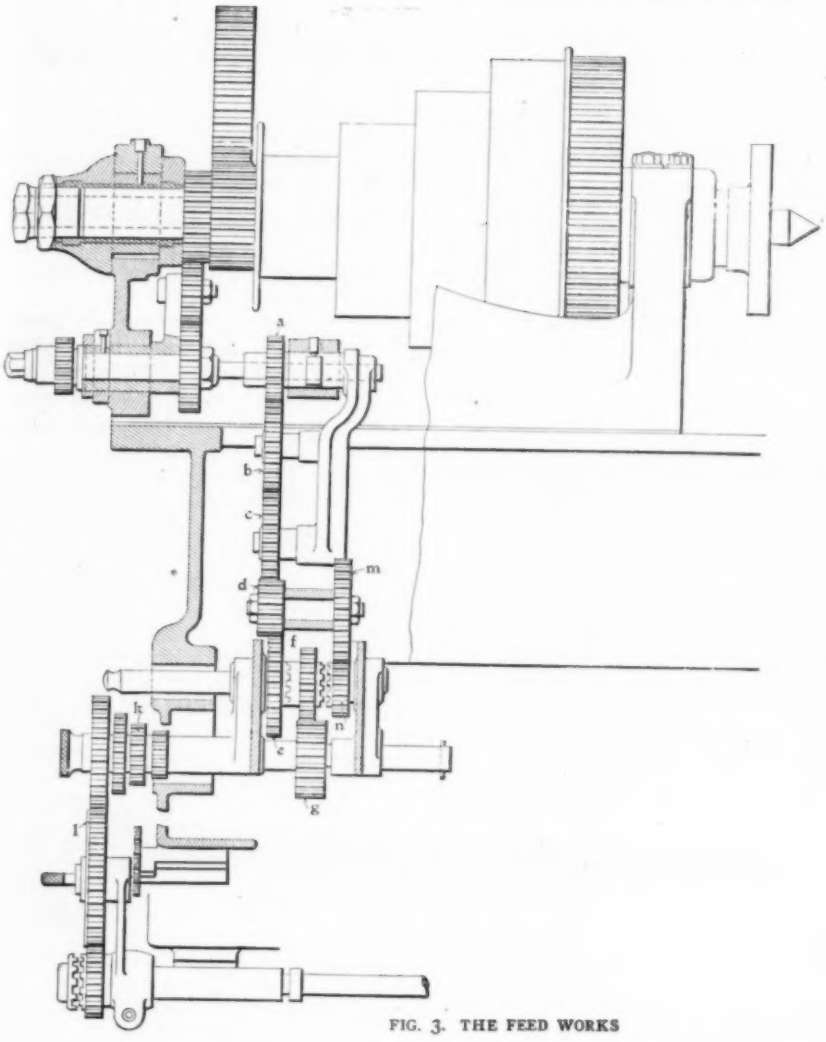


FIG. 3. THE FEED WORKS

shaft and bank of gears at a different speed and provides another set of four feeds. The range of feeds for the 18-inch lathes shown is from 8 to 96 per inch.

The lead screw, for thread cutting, is driven in the usual way by change gears and has no connection with the feed works. The feed works in the apron are driven by the worm and worm gear having a ratio of 60 to 1.

The lathe with 6-foot bed swings 2 feet 1 inch between centers, 20 inches over the bed and 12¾ inches over the compound rest.

These lathes are built by F. E. Reed Company, Worcester, Massachusetts.

Cylinder Turret Driller

This machine is for drilling, reaming, tapping, etc., on duplicate parts at proper speeds and feeds, without the necessity of changing the tools or the work, which is accomplished by means of a turret revolving on a vertical axis inside of the frame and carrying either four or six spindles as desired; the turret is revolved so that the spindle which it is wished to use is at the front; the driving gear connects with the gear on the spindle and causes the latter to revolve, the other spindles being back out of the way and idle, but being ready to be brought into position at once when it is desired to use the other sizes of drills. The same size gear is placed on all the spindles but one,

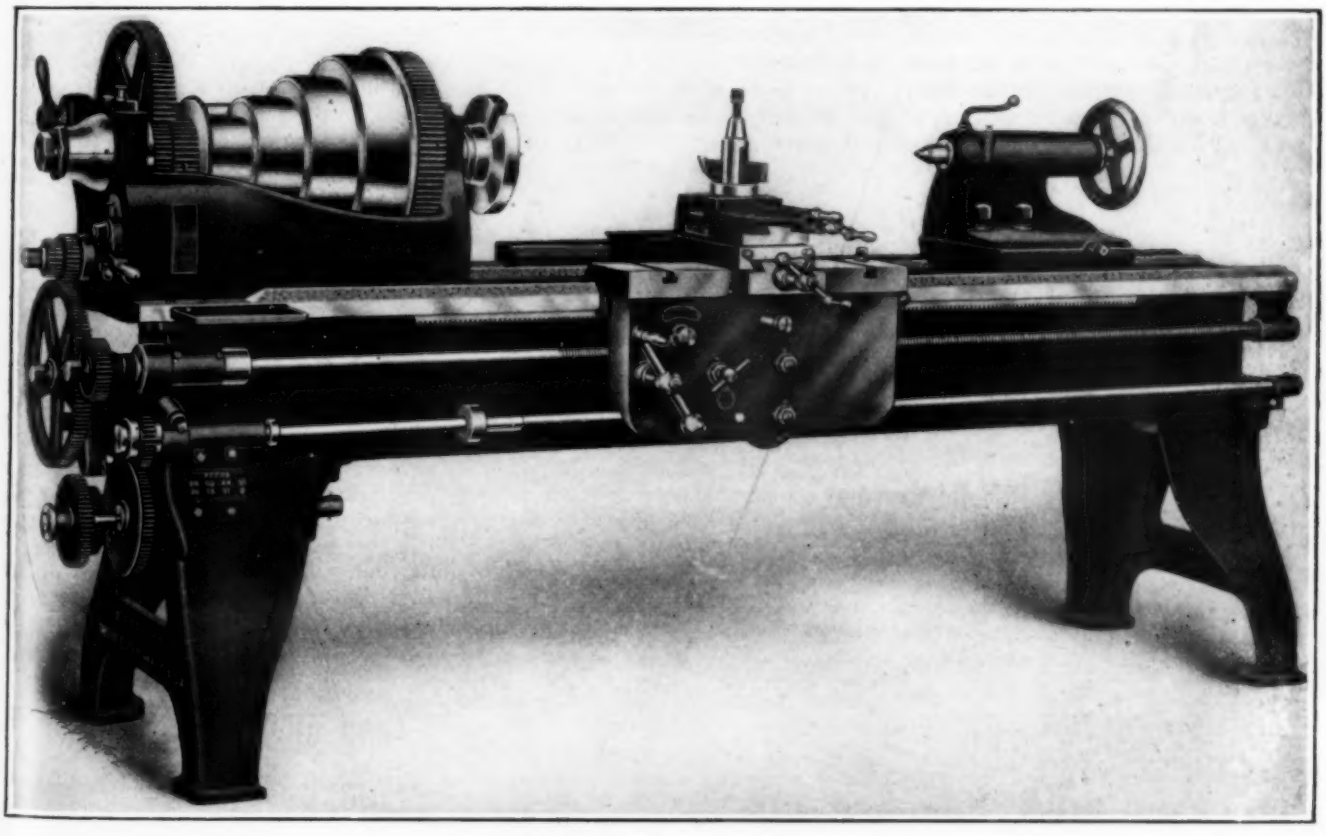
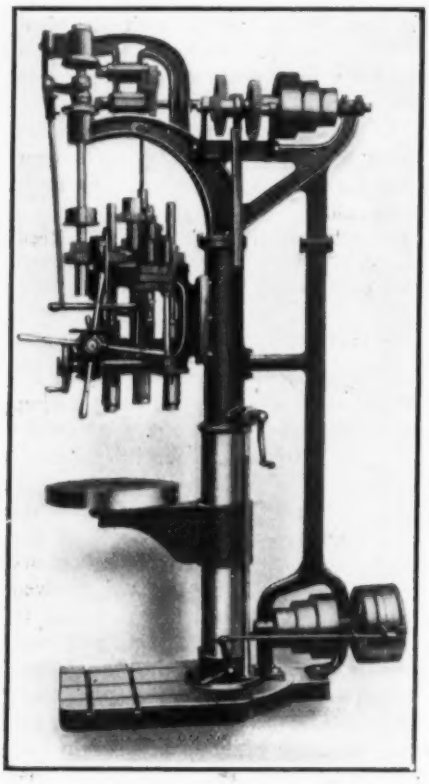


FIG. 2. HEAVY DUTY 18-INCH ENGINE LATHE

the latter being geared down for tapping and counterboring. All the spindles work to the same point on the platen. After the first tool is put in motion the operator may, if he wishes, place tools in the other spindles, which are not working.



CYLINDER TURRET DRILLER, FOUR-SPINDLE TYPE, WITH TAPPING ATTACHMENT

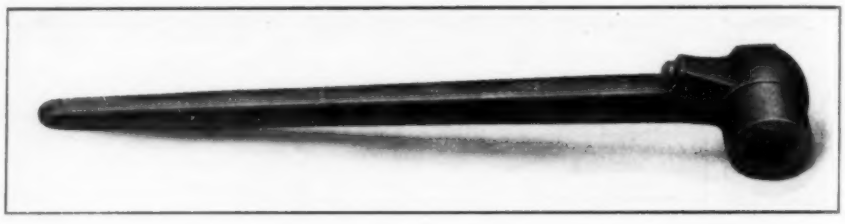
The machine can be furnished with either power, hand or lever feeds, or all of them; the spindle is set to the work directly by the star wheel, by the hand wheel in front, or by power, and can be set to stops to knock off automatically. The working strain is taken directly by the frame, the locking device being close to the spindle which is in use. The turret, which is hung on ball bearings, may be turned in either direction and locks automatically. The feed may be almost instantly changed by means of a lever in front of the operator. This machine will drill a hole in a 26-inch circle, and will carry 1⅜-inch drill in solid cast iron. The floor space occupied for size No. 1 is 48x24 inches, and its weight is 1200 pounds. It is made by the National Separator and Machine Company, Concord, New Hampshire.

A Handy Table for Drill Users

The Cleveland Twist Drill Company, Cleveland, Ohio, is distributing gratuitously a handy little accessory for the users of drills. It is made of three disks of celluloid pivoted at the center on an eyelet. The illustrations show the two sides of the device. On the one side the correct speeds for both carbon and high-speed steel drills from 1/16 inch to 3 inches diameter can be seen at a glance, and on the other the decimal equivalents (of the parts of an inch, divided into 64 parts) are given. Directions regarding feeds of drills and for determining the two principal causes of failures of drills are given on the face relating to drills. The little device is a handy size for the pocket, is substantially made and can be easily kept clean.

A Reversible Ratchet Socket Wrench

The illustration shows a socket wrench designed for the use of railroads, bridge builders, etc. The handle is of steel, drop forged, of channel section. These wrenches are made with 24-inch handles only and the sockets take either square or hexagonal nuts. The sockets are made for standard nut sizes from ¾ to 1¼ inches. This wrench is called the "Giant" and is made by the Keystone Manufacturing Company, Buffalo, New York.



A REVERSIBLE RATCHET SOCKET WRENCH

The greatest single consumption of brass is for condenser tubes; a battleship alone having from 30,000 to 40,000 lb. of condenser tubing in it; and owing to the corrosive effect of seawater this tubing must be continually replaced. The material used is usually either Muntz metal (60 per cent. copper, 40 per cent. zinc) or else a mixture of copper 70, zinc 29 and tin 1.

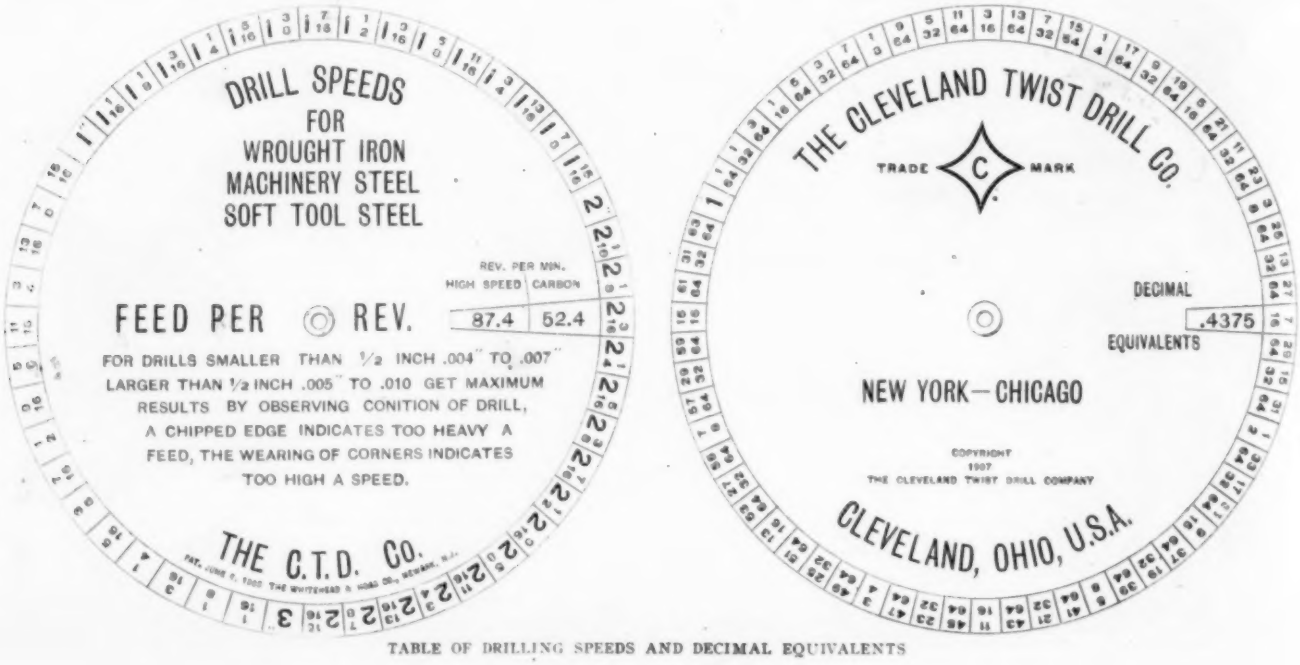


TABLE OF DRILLING SPEEDS AND DECIMAL EQUIVALENTS

National Machine Tool Builders Convention

(Continued from Page 603)

they sign the diplomas to be issued to the apprentices upon the completion of their apprenticeship.

NEW MEMBERSHIP

Eleven more firms have been admitted to membership. These are as follows: Aurora Tool Works, Aurora, Ind.; Champion Machine Tool Company, Cincinnati, O.; Cincinnati Lathe and Tool Company, Cincinnati, O.; Eberhardt Bros. Company, Newark, N. J.; E. J. Flather Manufacturing Company, Nashua, N. H.; Fellows Gear Shaper Company, Springfield, Vt.; Hilbert Machine Company, Cincinnati, O.; Lucas Machine Tool Company, Cleveland, O.; Mueller Machine Tool Company, Cincinnati, O.; Seneca Falls Manufacturing Company, Seneca Falls, N. Y.; Western Machine Tool Works, Holland, Mich.

ELECTION OF OFFICERS

The balloting for officers for the ensuing year resulted as follows: President, Fred L. Eberhardt, of Gould & Eberhardt, Newark, N. J.; first vice-president, C. A. Johnson, Gisholt Machine Company, Madison, Wis.; second vice-president, E. P. Bullard, Jr., Bullard Machine Tool Company, Bridgeport, Conn.; secretary, P. E. Montanus, Springfield Machine Tool Company, Springfield, O.; treasurer, W. P. Davis, W. P. Davis Machine Company, Rochester, N. Y.

EXCURSION TO FORT TOTTEN

On Thursday—the day following the adjournment of the convention—the members of the association and others connected with machinery interests, including several representatives of technical journals, enjoyed an outing provided by *Machinery*, the trip including a sail down New York harbor as far as Coney Island and then up the East river to Fort Totten, where a landing was made and the visitors to the number of about 450 had the opportunity of inspecting many features of interest connected with the post. The commanding officer, Col. G. N. Whistler, courteously detailed officers to explain to the visitors the operation of the range finders and other interesting apparatus at this important station. Luncheon was served on the boat and both the trip up and down the river and the visit to the fort were thoroughly enjoyed by the entire party.

The next convention of the association will be held in May, 1908, at Atlantic City.

Columbia University Evening Courses

Columbia University will offer at night during the year 1907-8 twenty evening courses specially adapted to the needs of technical and professional workers. This includes work in applied mechanics, architecture, electricity, fine arts, industrial chemistry, mathematics, and surveying and structures. The work begins on October 28 and continues for 25 weeks. A full description of the courses is contained in the Announcement of Extension Teaching, which may be obtained on application to the Director of Extension Teaching, Columbia University, New York City.

Business Items

The New Haven office of the Vandyck-Churchill Company, New York City, has been moved to Room 808, First National Bank building, 42 Church street.

The Warner & Swasey Company, Cleveland, Ohio, has opened a Chicago office in the Commercial National Bank building, Adams and Clark streets, under the management of E. B. Boye.

What is said to be the largest order ever placed for vises has just been awarded the Pittsburgh Automatic Vise and Tool Company, Pittsburg, Penn., by the Washington Terminal Railroad for use in their extensive new shops which have just been erected in the capital city.

The Rock Island Tool Company, of Rock Island, Ill., manufacturer of vises, has opened a New York office in the Electrical Exchange building, 136 Liberty street, to be in charge of Wm. M. Briggs, formerly connected with the L. S. Starrett Company, of Athol, Mass., in its New York office.

The Cutler-Hammer Manufacturing Company, Milwaukee, who recently purchased the Wirt Electric Company, of Philadelphia, have consolidated the Wirt business with that of their New York plant at Park avenue and One Hundred and Thirtieth street where the manufacture of Wirt apparatus will be continued.

Trade Catalogs

Rock Island Tool Company, Rock Island, Ill. Catalog and price list of vises. Illustrated, 22 pages, 6x9 inches, paper.

Lazier Gas Engine Company, 190 Main street, Buffalo, N. Y. Pamphlet and blue prints descriptive of vertical gas engines.

Niles-Bement-Pond Company, 111 Broadway, New York. Catalog of Pond rigid turret lathe. Illustrated, 44 pages, 6x9 inches, paper.

Arthur Koppel Company, Pittsburg, Penn. Catalog No. 227, describing portable industrial railways. Illustrated, 24 pages, 6x9 inches, paper.

Hollands Manufacturing Company, Erie, Penn. Catalog A2. Vises, machinists and plumbers tools. Illustrated, 72 pages, 5x7½ inches, paper.

Leonard Manufacturing Company, Providence, R. I. Folder illustrating and describing the Costello press for cutting, punching and forming.

The R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. Catalog of lathes, including engine, special turret, gap, motor driven, etc. Illustrated, 104 pages, 6x9 inches, paper.

Manufacturers

The Huntsville (Ala.) Wood Fibre Plaster Company will erect a plant.

Henry Disston & Son Company, Philadelphia, Penn., will enlarge its saw works.

The Hartlove Can Company, Baltimore, Md., will erect an addition to its plant.

The machine shops of the Wadley (Ga.) Southern Railroad were destroyed by fire.

The Union Wheel Works, Newark, N. J., has had plans prepared for a new factory.

The Williams Patent Crusher Company, St. Louis, Mo., will erect new factory buildings.

August F. Gallun & Sons, Milwaukee, Wis., will erect a tannery building to cost $80,000.

The J. W. Lathrop Company, Mystic, Conn., building gas engines, will erect a new shop.

The John Bruce Foundry Company, Cincinnati, Ohio, will erect a new $25,000 foundry.

The Coatesville (Pa.) Boiler Works, has purchased site for a new machine shop and foundry.

E. D. Jones & Sons Company, Pittsfield, Mass., will build an addition to their machine shop.

The Komp Machine Works, Hattiesburg, Miss., has awarded contract for the erection of a new plant.

Fire destroyed the plant of the United Leather Company, Wilmington, Del., causing a loss of $100,000.

The Western Steel Car and Foundry Company, Anniston, Ala., is reported as planning to manufacture steel cars.

Mr. Nitaro Kaji, 10 Kodenma-Uwacho, Tokio, Japan, would like catalogs of machinery, tools and hardware.

The McDonough Manufacturing Company, Eau Claire, Wis., building saw mill machinery, is erecting a new plant.

Contracts have been let by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, for an addition to the plant.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E. G. Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Clockwork and clock-operated mechanisms. Larchmont Mfg. Co., Larchmont, N. Y.

Experimental machinery, tools, model work, etc. E. A. Sheldon, New Britain, Conn.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Special machinery and manufacturing plants. Albert Pott, M. E., 23 Platt St., New York.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Orders in quantities for brass castings from ¼ to 2 lbs. in weight. Box 454, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Expert instructor, wants limited number of students in mechanical drawing, by mail. For particulars address Box 85, Annapolis, Md.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if it's "right." Roy Machinery Co., Minneapolis, Minn.

Apprentices and others wanting to pass examinations as licensed engineers need Tulley's Handbook on Engineering. A library in one volume of 1000 pages, $3.50. Hill Publishing Co., 505 Pearl St., New York.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Investments that pay, the books that give you more knowledge than your job requires; we can tell you the ones you need if you tell us your specialty; send for our 168-page catalog. Hill Publishing Co., 505 Pearl St., N. Y.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Wanted—High-grade machine work, especially for screw machines and turret lathes. We can refer to a very well known line of high-grade tools now on the market to demonstrate that we are able to do the highest grade of interchangeable work. Box 386, AMERICAN MACHINIST.

Arrange with us to do your manufacturing; we are thoroughly equipped for all classes of machine work, including screw machines and punch parts, tools, jigs, etc.; we design and build special and experimental machinery, also automobiles and marine gasolene engines. Forest City Specialty Manufacturing Co., of Rockford, Ill.

For progressive engineers; every practical engineer should compile his own note book; subscribe for Webber's tables, printed on 4x7" sheets for insert binders; every engineering subject, 25c. per sheet or ten for $1.00, printed both sides. Write for information to William O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, Mass.

An engineer with practical shop experience, with an expert mechanic as assistant, will be at liberty Dec. 1; we can increase your profits by a scientific study of details your superintendent is too busy to consider; time study, piece rates, manufacturing methods, design and construction of special tools, jigs or machines. Box 539, AMER. MACHINIST.

Wanted—An interest in a small or moderate sized machine shop, by a gentleman having a general knowledge of the business and who will have a small amount of machinery of rather high grade to build; buildings must be of recent construction, detached and having considerable vacant land for future extensions; tools and equipment must be fairly modern; location on some main line of railroad preferred; must be in a good labor market; all communications must be considered confidential by both parties. Box 525, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

COLORADO

Young, vigorous, broad gauged man with ten years' experience in manufacture of high-grade mining and electrical machinery, desires responsible place in organization of Eastern manufacturer; now employed, but wishes change location; is a successful salesman and sales manager; seeks connection only with concerns of unquestioned integrity. Address "C," Box 485, AM. MACH.

ILLINOIS

Designer with an extensive experience on automatic machinery and tools and familiar with presses and sheet metal dies, wishes to change. Box 542, AMERICAN MACHINIST.

Position wanted as foreman by A-1 machinist and toolmaker, technical educated, 30 years old; designer of special machines, tools, dies and fixtures for cheap and accurate production; first-class references. Box 514, AMERICAN MACHINIST.

INDIANA

General foreman for machine shop experienced on engines, machine tools, brass goods, valves and fittings; premium and piece work, cost reducing; technical education, married, references. Box 528, AM. M.

MASSACHUSETTS

Electrical draftsman, experienced on electric hoists, elevators and power stations, wishes steady position; A-1 references. Box 545, AMERICAN MACHINIST.

Situation as superintendent or assistant; eighteen years' experience engineering, foundry, machine shop and superintendent's office in large shop. Box 532, AMER. MACH.

NEW JERSEY

Manufacturing cost and general accountant; correspondent, purchasing agent; office manager; wishes to change. "High Class," AMERICAN MACHINIST.

General superintendent, 12 years' experience in modern shops, systematizer, successful hustler, at present executive of a large plant, wishes to change. Box 534, AM. M.

Superintendent or assistant; age 41; good mechanic and executive; large experience on machine tools and general work; capable of handling entire plant. Box 544, AM. M.

Toolroom foreman, experienced in designing, making, and supervising the making of tools, jigs, fixtures, dies, etc., for interchangeable product, wants position with reliable company; reference, and proven ability; complete details with interview or correspondence. Box 538, AMER. MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 517, AMERICAN MACHINIST.

Wanted—Position as draftsman; 2 years' experience. Box 537, AMERICAN MACHINIST.

Draftsman; young man; 23; technical graduate, experienced, desires position. Box 536, AMERICAN MACHINIST.

Mechanical draftsman of 12 years' experience on general machinery manufacture with shop experience, desires to change. Box 533, AMERICAN MACHINIST.

Mechanical draftsman and designer; Austrian, 26, with 8 years' shop and drawing room experience, wants position; A-1 references. Box 546, AMERICAN MACHINIST.

Young Japanese, mechanical, 2 years' experience, technical educated, wants position as tracer in machine shop, moderate wages "T. T.," 10 West 21st St., New York City.

Draftsman; 36 years; technical graduate; 13 years' drafting, shop; experienced automatic, special, conveying machines, typewriters, jigs, fixture, dies; wishes position. Box 541, AMERICAN MACHINIST.

Position wanted as superintendent, foreman or draftsman by young man, technical graduate with many years' shop and drawing room experience; used to handle men. Box 535, AMERICAN MACHINIST.

First-class foreman diemaker and toolmaker requires position as such or superintendent; expert on all classes of the most up-to-date labor-saving tools, blanking, forming, bending and drawing tools for electrical, telephone and telegraph instruments, etc.; excellent references. Box 547, AM. M.

Superintendent or head foreman by technical and a practical man, expert mechanic; designer of special machinery and tools, dies, jigs and fixtures for cheap and accurate production; executive ability and 21 years' experience; open for engagement; 38 years of age; highest references. Box 540, AM. MACH.

PENNSYLVANIA

Mechanical draftsman and designer, college graduate, with 6 years' experience on general work and special machinery wants position; also structural man, A-1 reference. Box 527, AMERICAN MACHINIST.

VERMONT

Wanted—Position by master mechanic skilled in scientific and economical manufacturing; place where work is put through in large lots preferred. Box 543, AM. MACH.

WISCONSIN

Mechanical and electrical engineer, familiar with electric crane design, desires change, experienced in sales and executive branches, capable of filling position of chief or managing engineer. Box 502, AM. MACH.

FOREIGN

Young Englishman desires position in garage or auto. works as assistant manager, tester, or mechanic; thoroughly acquainted with best French and English cars; trustworthy driver, excellent references. R. Brocks, 49 Woodhouse Road, Mansfield, Notts, England.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—First-class automatic screw machine operator; one who understands the Hartford horizontal turret preferred; also man to take charge of a mixed line of hand machines. Address The Standard Mfg. Co., Bridgeport, Conn.

INDIANA

Wanted—First-class blacksmiths in wagon department; give experience and wages wanted, with application. Address Supt. Wagon Dept., Studebaker Bros. Mfg. Co., South Bend, Ind.

Wanted—First-class foreman thoroughly versed on die and machine work, such as bulldozers, drop and trip hammers, punch, shear and trimming machines of all kinds, also forging machines, to forge and shape irons for farm wagon parts; state age and experience. Address Supt. Wagon Dept., Studebaker Bros. Mfg. Co., South Bend, Ind.

MARYLAND

Wanted—Two draftsmen on general heavy machinery. Address Ellicott Machine Co., Baltimore, Md.

NEW JERSEY

Wanted—A first-class draftsman, one who can speak English. Apply General Electric Co., Harrison, N. J.

Wanted—An experienced man to take charge of small brass foundry; must thoroughly understand metal mixing and be able to turn out first-class work. Box 530, AM. M.

Machinist experienced in the manufacture, installation and operation of marine gasolene engines to take charge of small shop; give references, wages and full particulars of experience. "Kent," Box 531, AM. MACH.

Chief engineer for a well established machine business; a young educated, experienced and thoroughly up to date man; only those who state age, nationality, experience, references, salary expected, etc., with full particulars will be considered; growing business and an opportunity for the right man. Address "G. S.," AMERICAN MACHINIST.

NEW YORK

Wanted in a machine shop within 15 miles of New York City, a first-class man as assistant foreman, between thirty and forty years of age, in a department of about forty hands; engine lathes, turret lathes, shapers, drill presses, vises, gear cutters, gear planers, milling machines, etc.; applicant must be a thoroughly first-class and all around mechanic on general jobbing work; must thoroughly understand the reading of drawings, and must also thoroughly understand how to handle men with a view to getting the best results. Address in own hand writing, stating age, nationality, past experience and wages required. "Foreman," P. O. Box 2062, New York City.

OHIO

Wanted—Draftsman, experienced on heavy machine tools, particularly boring mills above six feet; give experiences and salary wanted. Box 384, AMERICAN MACHINIST.

Wanted—First-class pattern shop foreman, on heavy machine work; must be good executive; give age, experience, references and salary expected. Box 508, AMER. MACH.

Wanted—First-class foundry superintendent for machine molding grey iron foundry of 50 tons capacity; the foundry is equipped in a strictly up-to-date manner; no hand molding; only green men employed; applicant must be strictly temperate in habits, of good character, aggressive and must possess an abundance of executive ability; full knowledge of all molding machines and best application of patterns is absolutely necessary; give full particulars and references; no cheap man need apply. Box 376, AM. M.

PENNSYLVANIA

On account of increased business we are constantly in need of high-grade planer, lathe and boring mill hands; also competent erectors; no labor troubles. The Blaisdell Machinery Co., Bradford, Pa.

We are increasing our capacity and invite applications from all classes of strictly first-class machinists; steady work, good wages, open shop, nine-hour day; no labor troubles. Riverside Engine Company, Oil City, Pa.

Draftsman—An Eastern college has a position open for a technical graduate, as instructor of mechanical drawing; applicant must have at least three years' drawing office experience; in answering, state age,

education, experience with references, and salary expected. Box 529, AMER. MACH.

Wanted—Strictly high-class foundry foreman; must be well up in manufacture of grey iron castings in weights of from five pounds to ten thousand pounds each; thoroughly familiar with molding machines and best application of patterns thereto; well up in piece work system and modern foundry practice; capable of handling ninety to one hundred molders, core makers, and laborers, and of producing at minimum cost; none but those possessed of experience and unquestionable references need apply; state salary expected. "Central," AMERICAN MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

FOREIGN

Master mechanic; Swede; practical and thoroughly acquainted with modern machine shop practice and experienced in handling men, wanted at once for new shop in Sweden; one with experience from locomotive and iron works preferred; good chance for the right man; none but an energetic and fully competent man need apply. "Practical," AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Two large Garvin hub machines for forming heavy work; will sell cheap. Schacht Mfg. Co., Cincinnati, O.

Machine shop for sale; $3000 a year; owner died; big sacrifice for cash. Address Box 112, Georgetown, Colo.

For Sale—A small machine shop equipped for automobile repairing and light jobbing. Address F. G. Pennock, 741 Washington St., So. Braintree, Mass.

For Sale—Ten volume library, covering completely the work of the engineer and machinist; good as new; cost $50; will sell for $15. Address "T. M. T.," Box 425, Chicago.

For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

For Sale—Machinist supply store, machine shop and brass foundry, in growing city; business established for 53 years and now in good paying condition; must be sold to settle estate; excellent opportunity for active young men. Address Henry Connard Estate, Reading, Penn.

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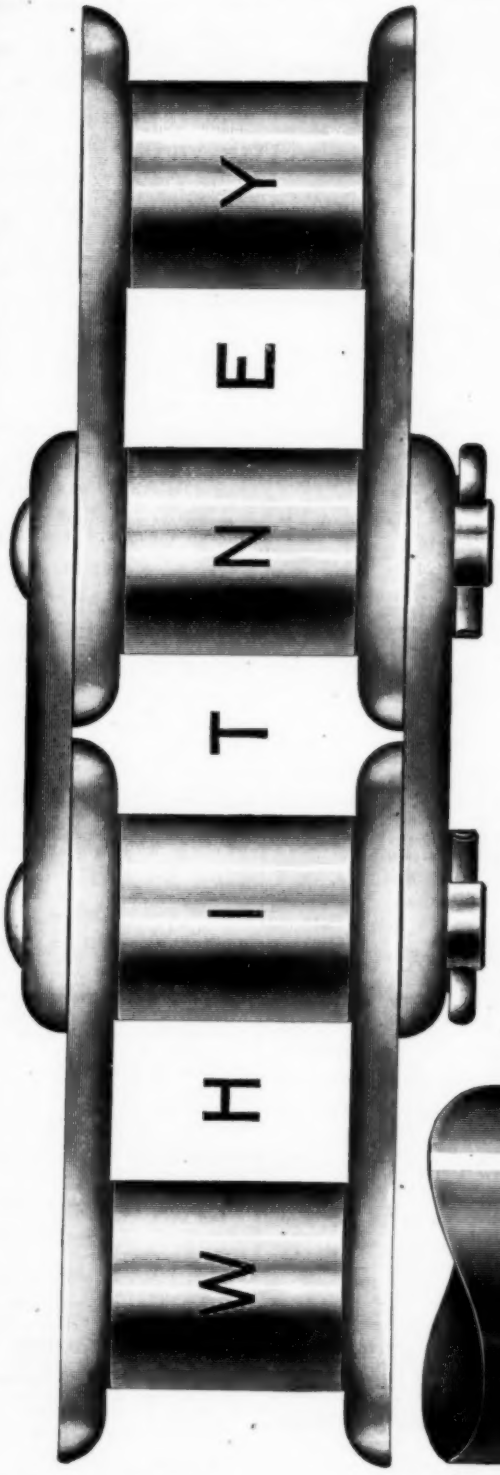

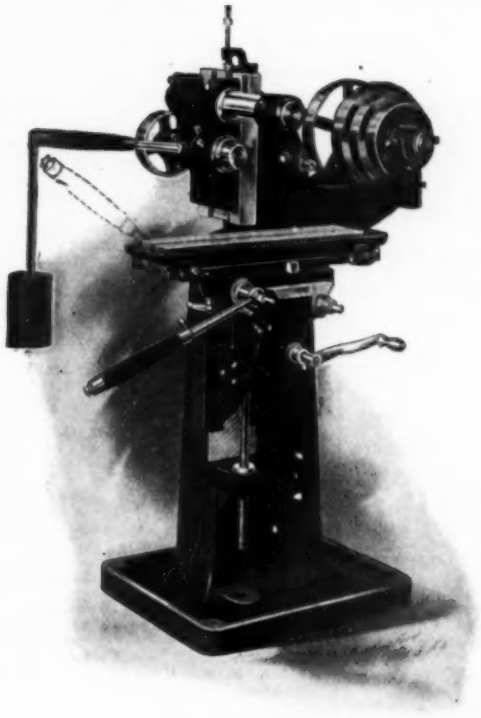

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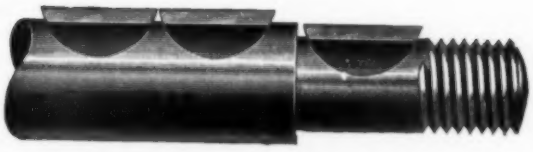

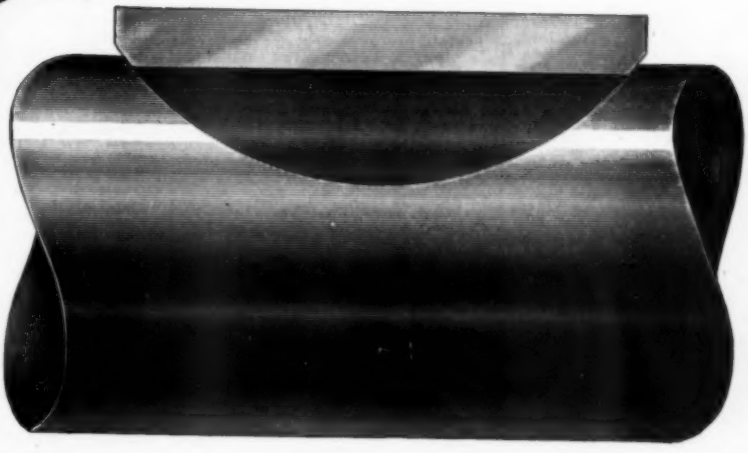

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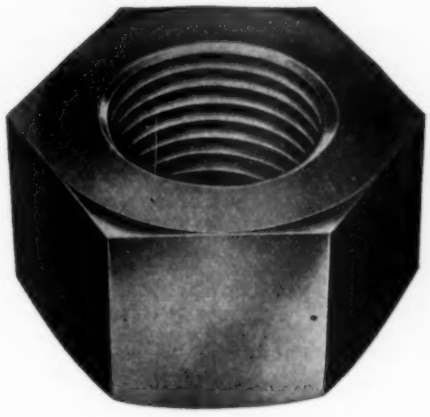

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Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Wks., Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fairbanks Co., Springfield, O.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, Ohio.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press

Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins

Winkley Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, O.
Mittineague Paper Co., Mittineague, Mass.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Mittineague Paper Co., Mittineague, Mass.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Dallett Co., Thos. H., Phila., Pa.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Dallett Co., Thos. H., Phila., Pa.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, O.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Chicinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret

Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.

Drills, Hand—*Continued.*

Dallett Co., Thos. H., Phila., Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Dallett Co., Thos. H., Phila., Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail

Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, Ohio.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
Eck Dynamo and Motor Co., Belleville, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madi-
Ridgway Dynamo & Engine Co., Ridgway, Pa.
son, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B .F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
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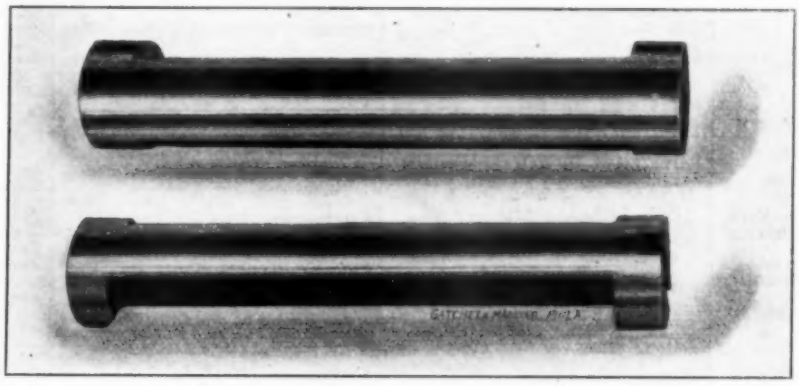

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Morse, Williams & Co., Phila., Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

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Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Mechanical and Electrical

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Dodge & Day, Philadelphia, Pa.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Engine Co., Stamford, Conn.

Engines, Oil

Remington Oil Engine Co., Stamford, Conn.

Engines, Steam

Buffalo Forge Co., Buffalo, N. Y. Ill.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric

Crocker - Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.

Fans, Electric—*Continued.*

Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Buffalo Forge Co., Buffalo, N. Y.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.

Filler, Iron

Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Fire Brick

McLeod & Henry Co., Troy, N. Y.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery

Scranton Co., The, New Haven, Conn.

Forgings, Drop

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Williams & Co., J. H., Brooklyn, N. Y.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic

Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine

Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel

Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Phila., Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.

Foundry Furnishings—*Cont.*

Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co, New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.
Witteman & Co., A. P., Phila., Pa.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester, City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam

Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gear Cutting Machinery—*Continued.*

Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Carey, Samuel, Glendale, L. I.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Foster Kimball Mach. Co., Elkhart, Ind.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
Morse, Williams & Co., Phila., Pa.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Perikns Mfg. Co., Springfield, Mass.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear Mach. Co., Phila., Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Carey, Samuel, Glendale, L. I.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

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Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Power Values for Machine Tools in Groups

Giving the Horse-power Required for 150 Machine Tools of Standard Shapes and Sizes and Showing How These Values Were Obtained

BY L. P. ALFORD

While connected with the engineering department of a large machine-building concern, the following problem was given to me: The machine equipment of the four factories which are to be consolidated into one manufacturing plant comprises over 2000 machine tools of various sizes, kinds and makes. What is the horse-power which will be required to drive these 2000 machine tools when they are arranged in groups and according to what is known as the one-shop plan?

The steps taken to solve this problem and the final data form the subject of this article.

It was of course easy to see that the information needed was horse-power values for all of the various machine tools when arranged and driven in groups. The existing factories were all mechanically driven and possessed no data which could be of value. An attempt was made to obtain the necessary information from outside sources. This attempt ended in failure. Nothing could be found in any publication, in the records of any engineering society, or from other engineers which could be of value under the existing conditions. It was therefore determined to carry out a lengthy series of tests in order to provide data, which could be relied upon and which would apply specifically to the problem in hand. These experiments were conducted over a period of about six months and at a cost probably exceeding $5000.

Purpose of the Tests

It was the purpose to find, by actual test, the horse-power required to drive all of the various machine tools in the factory equipment, under actual shop conditions and in groups. Fortunately the factories in which the machine tools were located were, in general, arranged on what is known as the one-shop plan, i.e., machine tools of a given size and kind were arranged in separate departments and driven from individual lines of shafting.

As we have stated, it was the purpose to keep all of the conditions actual shop conditions; thus the data are far different from those which are obtained from laboratory conditions. Again, the individual machine tool was lost sight of, except as requiring an average power value, and as many tools as possible were in the groups which were tested.

Methods Employed

In general the method employed in making the observations consisted in detaching lines of shafting, which drove the group of machine tools to be tested, from their main driving belts and then driving these lines so detached by means of an electric motor, measuring the horse-power input of the motors for conditions of average running of the groups of machine tools and for conditions with none of the machine tools running, in order to obtain the friction load. These observations were corrected for motor efficiencies, and thus the actual motor output was obtained for the different conditions. In case a given department, as for instance a milling-machine job, contained machine tools of various sizes and types, a process of elimination was used to get the individual values.

In general, each department was tested for a full working day, including an afternoon and a morning run. No effort was made to change the character of the work on the machine tools in any manner whatever. An effort was made, however, to have all the machine tools in the department under test running during the progress of the test.

There were two reasons for this procedure. The average results were, of course, better from the group-drive standpoint the larger the number of machines in use. Again, with all of the machine tools in use the factor of *machine-tool slip*, so called, was cared for in the individual results obtained. By machine-tool slip I mean the lessening of the average power required by a machine tool in a group, due to the fact that at times every machine is temporarily shut down, due to the absence of the operator, the setting up of work, removing dulled tools and replacing them with sharpened ones, putting in material, taking out the finished pieces, gaging of the work, accidental stoppages, etc. As I have indicated, with all of the machine tools in the group running, this factor would be automatically taken care of in the results obtained for that group. In addition to this machine-tool slip, there is another factor of slip, or lessening of the average power values for the machine tools, which I prefer to call *departmental slip*. This will be treated of in detail at another section in this article.

Apparatus Used

The testing outfit consisted of three direct-current motors of 5, 10 and 35 horse-power respectively. With them was used a set of indicating instruments from which the current was observed. Three motors were employed in order that the power used by the department being tested might not be too disproportionate to the normal load of the motor. Carefully prepared curves giving the efficiency of each machine throughout the power range for which it was used were obtained from the motor builders.

It is needless to point out that a great deal of labor was involved in moving these motors from one location to another throughout the factory buildings, in preparing and installing proper countershafts in order to keep the speed of the line shafting the same as when under normal working conditions, and in detaching these lines of shafting from their regular drives.

In general, observations were taken every five minutes. These observations included the number of the observations, the time of day, the observed voltage, the observed amperage, the observed horse-power by calculations, the motor efficiency from the efficiency curves and the actual horse-power by computation. A record was also made of all the machine tools belted from the shafting which was driven by the motor, and at the time of each observation the machine tools actually operating were noted. Fig. 1 is a specimen page from a test of a grinding department and is typical of the manner in which the observations were taken and tabulated. Many thousand observations were made, and the results or the power values for the individual machine tools are given in Table 1.

Limitations of the Data

In considering or using these data, their limitations should be very fully appreciated. The experiments were made about four years ago, and prior to the general introduction of high-speed steel. The machine tools are in general in what is considered the light or medium class. They were used upon parts for light automatic machinery. These parts were in general castings and forgings which had very little finish, so that the work of the cutting tools was light. This fact outweighs the point which has been noted, that the tests were made prior to the introduction of high-speed steels; for the field of the high-speed steel is in removing large quantities of stock. As these data were collected on finishing cuts or at least on very light cuts, they have the same value today which they had when they were first compiled. They were collected for conditions of group driving, and therefore are valueless from the standpoint of individual driving.

Departmental Slip

We have referred to departmental slip in an earlier part of this article. This expression is used as applying to that lessening of the average horse-power values of machine tools due to working conditions in the department. The factor of machine-tool slip was cared for by the method of testing. This factor of departmental slip, or which possibly might be characterized as factory slip, was obtained in the following manner: All of the machine tools in the existing factories were listed, and to them were applied the individual power values of the preceding tabulation. During the progress of the general tests the horse-power load for the entire plant was very accurately obtained. The value obtained from the factory tests, that is, the horse-power actually used by all of the machine tools in the plant, was checked against the value obtained by computation after applying the individual horse-power values to the entire machine-

Kind.	Size.	Observed Horse-power. Maximum.	Observed Horse-power. Average.	Remarks.
Boring Machines.				
Bullard, single head	36"	0.78	0.52	
Bullard, double head	42"	1.72	1.08	
Cam Cutters.				
Brainard	No. 2.		0.67	
Brainard	No. 4.	0.48	0.32	
Brainard	No. 5.	0.48	0.32	
Lathe type, single head			0.32	
Lathe type, double head			0.50	
Cutting-off Machines.				
Hurlbut-Rogers	1¼"		0.12	
Hurlbut-Rogers	2"	0.28	0.14 to 0.18	
Hurlbut-Rogers	3"	0.34	0.20 to 0.22	
Drilling Machines.				
Prentice Bros. radial	No. 0.		0.72	
Prentice Bros. radial	No. 1.	3.18	1.12	
Woodward & Rogers	Sensitive single-spindle.		0.31	
Dwight-Slate	2-spindle.		0.32	
Woodward & Roger	Sensitive 3-spindle.		0.35	
Woodward & Rogers	4-spindle.		0.48	
Woodward & Rogers	6-spindle.		0.71	
Prentice upright	16"		0.25	
Prentice upright	18"		0.35	
Prentice upright	20"		0.42	
Prentice upright	22"		0.50	
Blaisdell upright	24"		0.47	
Blaisdell upright	26"		0.22	
Blaisdell upright	28"		0.25	
Blaisdell upright	30"		0.30	
Blaisdell upright	34"		0.45	
Blaisdell upright	36"		0.53	
Blaisdell upright	46"		0.63	
Blaisdell upright	50"		0.83	
Gear Cutters.				
Brainard	No. 4½.		0.15 to 0.32	
Gould & Eberhardt	No. 3.		0.20	
Brown & Sharpe	No. 3.		0.20	
Grinders.				
Brown & Sharpe cutter and reamer grinder	No. 3.		0.32	
C. H. Besly & Co. Gardner grinder	No. 4.	1.42	0.53	
Brown & Sharpe plain	No. 11.		0.80	
Brown & Sharpe surface	No. 2.		0.40	
Brown & Sharpe surface	No. 3.		0.50	
Brown & Sharpe universal	No. 1.		0.60	
Brown & Sharpe universal	No. 2.		0.76	
Diamond wet tool grinder		3.20	0.97	Carrying 1 20-inch wheel.
Leland & Faulconer wet grinder			0.41 to 0.82	Carrying 2 24-inch wheels.
Drop Hammers.				
Blondell	40 lb.		0.10	
Pratt & Whitney	250 lb.		2.00	
Pratt & Whitney	400 lb.		2.50	
Pratt & Whitney	600 lb.		3.00	
Pratt & Whitney	800 lb.		3.50	
Pratt & Whitney	1000 lb.		4.00	
Billings & Spencer	1500 lb.		5.00	
Power Hammers.				
Bradley	100 lb.		1.50	
Bradley	150 lb.		1.75	
Keyseater.				
Baker Bros.	No. 4.	0.64	0.28 to 0.32	
Lathes.				
Reed boring lathe	20"		0.35	
Reed boring lathe	30"		0.41	
Reed engine lathe	12"		0.24	
Reed lathe	14"	0.48	0.26	
Prentice	16"		0.34	
Reed	16"	0.48	0.36	
Blaisdell	18"		0.39	
Blaisdell	20"		0.44	
Reed	22"	0.37	0.32	
Reed	24"		0.25	
Blaisdell	24"		0.31	
Prentice	28"		0.31	
Draper	38"		0.58	
Reed speed lathe	10"		0.10	
Reed speed lathe	14"		0.12	
Lathes—Continued.				
Putnam squaring-up lathe	15"		0.25	
Gisholt turret lathe	Size H.		0.70	
Potter & Johnston semi-automatic	No. 1.	1.63	0.33 to 0.63	
Jones & Lamson flat turret	2 x 24"	1.97	1.20 to 1.80	
Wood turning lathe	14"		0.31	
Wood turning lathe	16"		0.36	
Wood turning lathe (Putnam gap)	36"	1.50	1.30	
Milling Machines.				
Brainard	No. 1.	0.47	0.30	
Brainard	No. 3.	0.64	0.26	
Brainard	No. 4.		0.19 to 0.29	
Brainard	No. 4½.		0.13 to 0.19	
Brainard	No. 6.		0.26	
Brainard	No. 7.		0.83	
Brainard	No. 14.		0.25	
Brainard	No. 15.		0.25	
Becker vertical	No. 3.		0.26	
Becker vertical	No. 5.		0.55	
Becker-Brainard	No. 3.		0.17 to 0.25	
Brown & Sharpe	No. 1.		0.15	
Brown & Sharpe	No. 2.		0.25	
Brown & Sharpe	No. 5.		0.30	
Reed	No. 7.		0.83	
Pratt & Whitney hand	No. 1½.		0.20	
Planers.				
Whitcomb	17"	2.01	1.00 to 0.43	
Whitcomb	22" x 5'	2.34	1.16 to 0.53	
Putnam	22" x 5'	1.44	0.70	
Putnam	24" x 6'		0.84	
Putnam	26" x 5'	1.59	0.81	
Putnam	30" x 6'	4.91	1.31	
Putnam	30" x 8'	5.46	1.56	
Putnam	36" x 10'	4.00	1.60	
Powell	50" x 9'	2.94	1.14	
Pond	34"	7.75	3.70	
Wood panel planer	24"	3.40	2.00	
Wood surface				
Polishing Stands.				
Brown & Sharpe	No. 3.		1.00	
Diamond	No. 5.		1.19	
Punch Presses.				
Bliss	No. 3.	2.30	1.26	
Profiling Machines.				
Garvin	No. 1.		0.50	
Pratt & Whitney	No. 6.		0.40	
Band Saw.				
Fay & Co.	36" wheels.	3.00	0.87	Used for pattern work.
Circular Saws.				
Kimball Bros.	9" blade.	3.77	1.05	
Whitney	9" blade.	3.75	1.04	
White	13" blade.	5.82	1.21	
Hack Saw.				
	12" to 14"		0.06	
Screw Machines.				
Brown & Sharpe automatic	No. 1.		0.60	
Pratt & Whitney automatic	No. 2.		0.37	
Pratt & Whitney	No. 2.		0.72	
Pratt & Whitney	No. 3.		0.80	
Brown & Sharpe automatic	No. 3.		0.80	
Pratt & Whitney automatic	No. 3-O.	1.04	0.90	
Pratt & Whitney	No. 3-B.	1.04	0.90	
Brown & Sharpe	No. 00.		0.36	
Cleveland	⅝"		0.40	
Cleveland	2"		0.87	
Cleveland	2½"	1.04	0.90	
Pratt & Whitney hand	No. 2.		0.43	
Pratt & Whitney hand	No. 2½.		0.47	
Pratt & Whitney hand	No. 3.		0.50	
Shapers.				
Lodge & Davis	14"		0.35	
Hendey	20"		0.50	
Hendey	24"		0.52 to 0.70	
Hendey	28"		0.52 to 0.70	
Tapping Machine.				
Pratt & Whitney	No. 2.		0.10	

TABLE 1. POWER VALUES FOR MACHINE TOOLS IN GROUPS.

tool equipment. Certain classes of machine tools were eliminated, such as speed lathes, grindstones, tool grinders, snagging grinders and others which are intermittent in their use. A comparison of the gross horse-power value so obtained showed that the sum of the individual power values was 20 per cent. higher than the actual horse-power used in the factories. Therefore in using these data for the purpose for which they were collected, the values obtained for the various departments by using the individual machine-tool values as given in this article were reduced 20 per cent. before being used to determine the size of motor required. Two other exceptions were also made in its use. The power values were reduced one-half when applied to the machine tools of the jig- and fixture-making department and to the experimental department. The reason is obvious, as the tools are there used intermittently and with light cuts and fine feeds.

For woodworking machinery, maximum values were used to get motor capacity for the acceleration to the high speeds required. Aside from this one instance the maximum values given in the tabulation are valueless.

Check of the Application of the Data

The horse-power values given in the preceding calculation were used for the purpose for which they were obtained with the following results: Motor sizes were determined upon for all the various departments, and after these departments had been thoroughly organized and in operation about one year, each motor was tested in order to determine its horse-power output for comparison with the motor rating. The motors were three-phase, 550-volt, 60-cycle and, in general, of the internal-resistance type. While not all of the motors whose sizes were obtained in this manner are listed in Table 2 yet all of those which give comparative values are so noted. In some departments special conditions crept in as the departments were organized, so that the final basis upon which the department was operating differed from that which was assumed when making the original calculation. Therefore the conditions surrounding the values given are such as to make the horse-power output of the motor when tested on a truly comparative basis with the original calculations.

Factory Department.	Horse-power rating of the motor.	Horse-power output of the motor.
Automatic screw machine	50	69.97
Cuttermaking	20	24.60
Cuttermaking	30	23.59
Drilling, light	30	35.39
Drilling, heavy	30	36.79
Experimental	20	20.96
Grinding	40	45.94
Hand screw machines	30	32.74
Jig and fixture making	30	29.15
Lathes	40	35.07
Milling	40	39.37
Patternmaking	40	25.07
Planers, heavy	50	42.80
Planers, light	40	39.37
Totals	490	500.91

TABLE 2. POWER VALUES FOR DEPARTMENTS.

A consideration of the totals clearly shows that the ends reached justified the means and proves the accuracy of the individual power values for the conditions to which they were applied.

Of course the friction load of each department formed a part of the motor load. This quantity was cared for by a flat percentage of the estimated power required by the machine tools themselves. A discussion of this feature will be made the subject of another article.

Date. Feb. 9, 1903.

A	B	C	D	E	F	G	H
No. of Ob.	Time of Day	Ob. Volts.	Ob. Amp.	Ob. H.P.	Eff. of Motor.	Actual H.P.	Remarks.
114	1.30	114	106	16.09	85.10	13.69	3 No. 2S, 1 No. 11, 2 No. 2U, 1 No. 1U, 1 Polisher, 1 Gardner.
115	1.35	114	98	14.97	84.40	12.64	2 No. 2 S, 1 No. 11, 2 No. 2U, 1 No. 1U, 2 Disk, 1 Polisher, 1 Gardner.
116	1.40	113	104	15.75	84.95	13.38	3 No. 2S, 2 No. 11, 2 No. 2U, 1 No. 1U, 1 Polisher, 1 Gardner.
117	1.45	111	120	17.84	86.15	15.37	4 No. 2S, 2 No. 11, 2 No. 2U, 1 No. 1U, 1 Polisher, 1 Disk.
118	1.50	113	104	15.75	84.95	13.38	4 No. 2S, 1 No. 11, 2 No. 2U, 1 No. 1U, 1 Polisher, 1 Gardner.
119	1.55	111	114	16.90	85.75	14.50	3 No 2S, 2 No. 11, 2 No. 2U, 1 No. 1U, 1 Disk, 1 Gardner.
120	2.00	112	110	16.50	85.40	14.10	3 No. 2S, 1 No. 11, 3 No. 2U, 1 No. 1U, 1 Disk, 1 Gardner.
121	2.05	113	102	15.44	84.80	13.10	3 No. 2S, 1 No. 11, 3 No. 2U, 1 No. 1U, 1 Disk, 1 Gardner.
122	2.10	112	110	16.50	85.40	14.10	2 No. 2U, 1 No. 11, 3 No. 2S, 1 Disk, 1 Gardner, 1 Polisher.
123	2.15	112	104	15.60	84.85	13.24	2 No. 2U, 2 No. 11, 3 No. 2S, 1 Disk, 1 Gardner, 1 Polisher.
124	2.20	112	104	15.60	84.85	13.24	2 No. 2U, 2 No. 11, 3 No. 2S, 1 Disk, 1 Gardner, 1 Polisher.
125	2.25	112	104	15.75	84.95	13.32	2 No. 2U, 1 No. 11, 4 No. 2S, 2 Disk, 1 Gardner, 1 Polisher.

FIG. 1. SPECIMEN SHEET OF OBSERVATIONS.

Telpherage Railway Systems

Telpherage systems have been in use for many years in connection with some manufacturing plants, and occupy a very important place in the handling of large quantities of material, provided the surrounding conditions are adapted to their use. They are comparatively inexpensive to construct under ordinary conditions, are in a great measure independent of the character and grades of the soil of the country over which they pass, can be taken around sharp curves and require a minimum of labor to operate.

A new field for such telpherage systems is being considered at the present time. Several of the leading railway men of our country have been devoting attention to this system; studying its adaptation to railway traffic in sparsely settled or mountainous sections. At the present time the great main arteries of railway travel throughout the United States have been well provided for. Many feeder lines, however, are required. These feeder lines, which must tap the entire surrounding country for the main trunk lines, are sorely needed and a successful and satisfactory solution of their type of construction is essential. If the telpherage system is adopted, our next phase of traffic development, instead of being a construction of broad-gage tracks with heavy rolling stock, will be of light railways of the overhead type, inexpensive to construct, equip and operate. In general such construction consists of two lines of stringers laid with 20-pound rails and carried on a series of trestle bents. The trains which are operated under this system are made up of light corrugated iron cars, circular in section and supported by iron straps, from two 2-wheeled trucks. The forward truck of the motor car is provided with a motor, and a short trolley pole engages with an overhead trolley wire which is carried on the same structure as the rail. It is needless to point out the cheapness of this construction. One of the notable advantages of such a telpherage system is that the method of supporting the track or cable is capable of wide variation to suit the topographical difficulties of the country which is being traversed. Heavy bridges, deep cuts, substantial trestles, high embankments and laboriously dug tunnels are unnecessary, as the line may be so surveyed as to cross the loftiest mountains or to pass around hills and rocky bluffs. It will be of interest to watch the developments which will take place along this line during probably a very few ensuing years.

The thing that starts easy, runs fast and far with lots of heat and friction, and then stops slow is a quarrel.

Automobile Change Gears and Their Journals

How Such Gears and Journals Should Be Designed by Attention to Certain Essentials and an Analysis of Many Constructions *

BY HENRY HESS†

Change gears are now so generally being mounted on ball bearings that such practice, not only with us, but in Europe as well, may fairly be considered as standard.

Within the past ten years I have had considerable occasion to suggest suitable bearings, very often without being given the necessary data. Questions would take some such shape as: "What bearings shall I use for the change gear of a touring car?" Requests for the power of the car, its weight, the intended arrangement of the gear were, not as infrequently as a gathering of engineers might think, obviously considered as a prying into affairs that did not concern the bearing makers.

At first sight it would seem a very simple matter to take a given arrangement of gears, consider the power transmitted through them, their speed and position relatively to the journals and then, having calculated the load on the journals, pick out suitable bearings.

But—who knows how large a portion of the available maximum power of the engine is employed with any one gear reduction? Who knows for how large a portion of the average load hours the load is carried by a given set? Who knows what the average power exerted is, anyhow? Who knows what the maximum is for a 28-30 horse-power engine that is, however, said to really develop 40 horse-power on cylinder diameters for which other builders claim anything between 10 and 50 horse-power?

Obviously, the only practicable way out is to reduce to some sort of system the results reached by experience and observation during many years—many, that is, as measured by the history of a lusty infant industry that has cheerfully honk-honked its way to the front rank, not even restrained by false modesty from putting "Gabriel's" horn to an earlier than the intended use.

As a failure to observe a few cardinal principles in mounting ball bearings may readily give unsatisfactory results, even when a suitable size selection has been made, a brief consideration of these principles is first in order. The illustrations given, are, as a rule, typical only, with a few exceptions, which are reproduced from the actual practice of builders who have courteously granted such permission, while others are reproduced from the pages of technical journals.

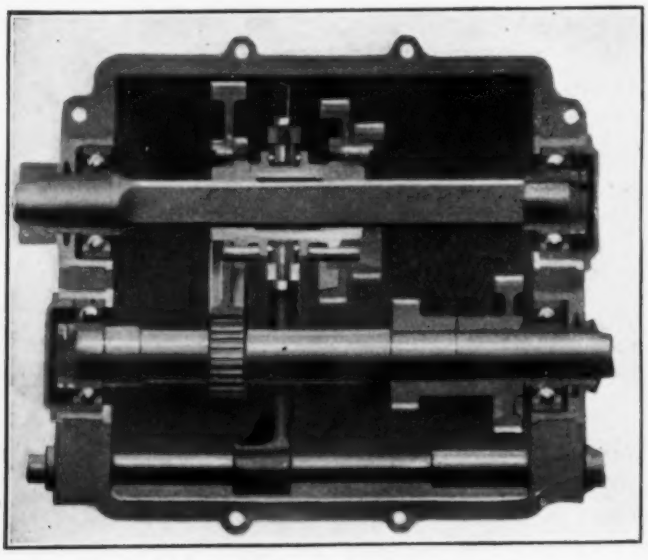


FIG. 1. A WELL MOUNTED AMERICAN GEAR

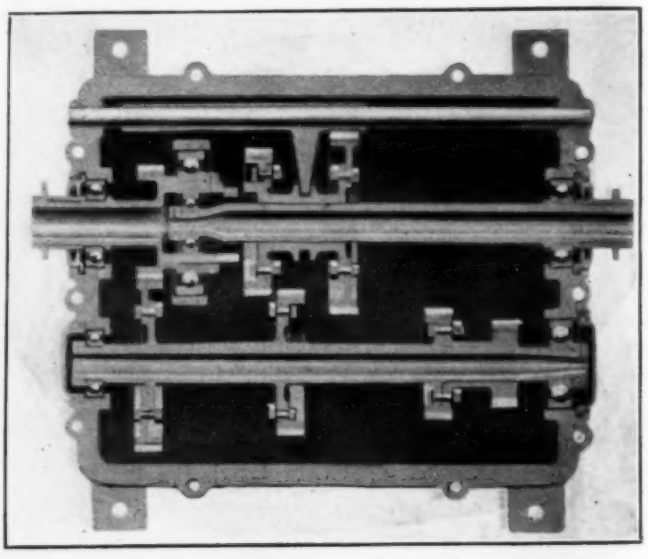


FIG. 2. A TYPICAL ILLUSTRATION OF GOOD FRENCH PRACTICE

See Fig. 1. One ball bearing only should be employed to a journal. The very natural resort to two or more light bearings to carry a heavier load will not answer. Slight inaccuracies of mounting, deflections of the shaft or housing, temperature effects, etc., will prevent the equalization of load between such multiple bearings, so that at times only one will be called on to do all the work. If it is not equal to that task it will go to pot, and the others will follow. Heavier bearings must be used for heavier loads, not more light bearings.

A bearing intended to take radial load should be so mounted that no end thrust may be imposed upon it. For that reason either the outer or the inner race should be a slip fit. Were both races drive fits, the one on the shaft and the other in the housing, their seating would have to be by end pressure exerted through the balls, which would probably not be relieved, and so remain to reduce the bearing's radial-load capacity, possibly very considerably.

The inner race should be a tight, and the outer a slip fit. This holds for all such sizes as are used in automobile work. The reason is that the continuous hammering of the load will peen down the softer material of the shaft or housing and show this effect more on the shaft. Consider that as between opposing convex and concave surfaces of hammer and anvil the convex surface will be soonest affected. It is the shaft that is convex, and that is softer than the bearing, while the housing seat has the more resisting concave shape and the larger surface.

The inner race should be securely clamped between substantial shoulders on the shaft and a nut or its equivalent. This is because experience has shown that, although a drive fit is sufficient to hold the race, an intention to have a drive fit is effective only if translated into practice and only for so long as it is maintained after that. Pulling a bearing off and on a few times, or the reducing effect of the road peening will destroy the fit. But the frictional grip between a sufficient shoulder and a good nut will damp out the road vibrations so that the shaft will not be peened down.

*A paper presented to the Society of Automobile Engineers.

†President Hess-Bright Mfg. Co., Philadelphia, Penn.

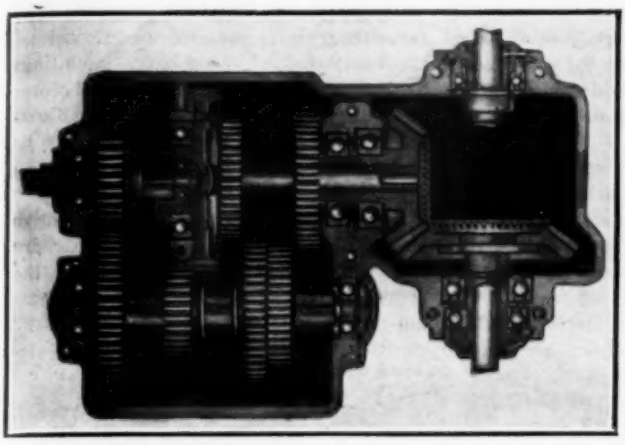


FIG. 5. SEPARATE BEARINGS USED FOR THRUST AND RADIAL LOADS

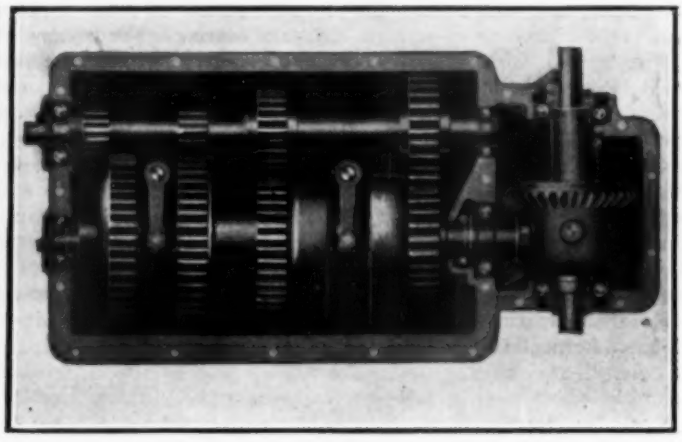


FIG. 6. THRUST OF BEVELS TAKEN ON BEARINGS OF COLLAR TYPE

When a shaft is to be secured against endwise shifting, whether in one or both directions, that office should be assigned to one bearing only, whose outer race should be then clamped between shoulders in the case. Observance of this rule will benefit the shop, since it is not only difficult, but costly to secure an accurate endwise relationship between shoulders on a shaft and a case. If such relationship is not secured then forcible assemblage will introduce uncontemplated and destructive end thrusts. The same thing results from a deflection of shaft or housing, as well as from unequal expansion or contraction under the influence of temperature variation.

The bearings must be so housed in as to retain lubricant and exclude dust, grit, etc. An impression that ball bearings will operate without lubricant is more general than one might think. It is barely possible that absolutely true spheres might roll on absolutely true surfaces if both were made of materials that were absolutely inelastic and therefore would remain true under load. But since such absolute perfection of shape is not to be had, such possibility is not of interest to the practising engineer, who must, therefore, provide and retain lubricant.

Since not the wildest stretch of imagination will construe that grit is a lubricant, the necessity of its exclusion is, I should like to say it, apparent enough, were it not for the fact that I have run across mountings so exposing the bearings that grit from trap (or cement) rock-surfaced roads had, together with moisture, formed a cement ring between the inner and outer races, absolutely concealing the balls and binding the two races and the balls into a solid lump.

Fortunately, merely suitable shaping of parts will not only serve to retain lubricant, but to, at the same time, exclude foreign matter.

Experience and most carefully conducted tests have proved that long life under load can be realized from ball bearings only when the surfaces are not only true, but are also highly polished and smooth. Roughnesses will be broken down and leave still greater roughnesses. Rust and acid will destroy originally true and smooth surfaces. Since not a few lubricants contain free acids, care in their choice must be exercised. Plentiful lubrication and a properly closed mounting are safeguards against rust.

Fig. 1 is a familiar American gear, and is very well mounted: The inner races are clamped between shoulders and nuts or between shoulders, tubular pieces, the hubs (shown partially), or other elements outside of the case, that are in turn driven home by nuts (not shown). The outer races are slip fits; those at one end are free endwise to take up an unrestrained position, while those at the other end are held between a shoulder in special containers and end cover caps.

The employment of bearing containers is optional. If the case is of rather soft material a container of harder material is advisable. Aluminum alloys are to be had nowadays sufficiently hard to take the bearings directly. Containers are preferred by some designers who wish to use a different lubricant in the bearing from that slushing the gears. Again, some use the containers as a convenient means for adjusting parts in their endwise relationship by simply shifting the containers in

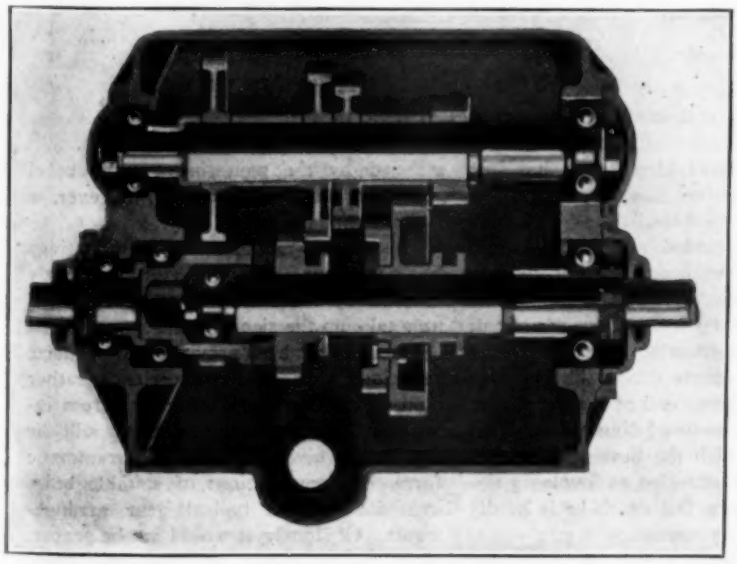


FIG. 3. A GERMAN TYPE FOR A 30-H. P. CAR

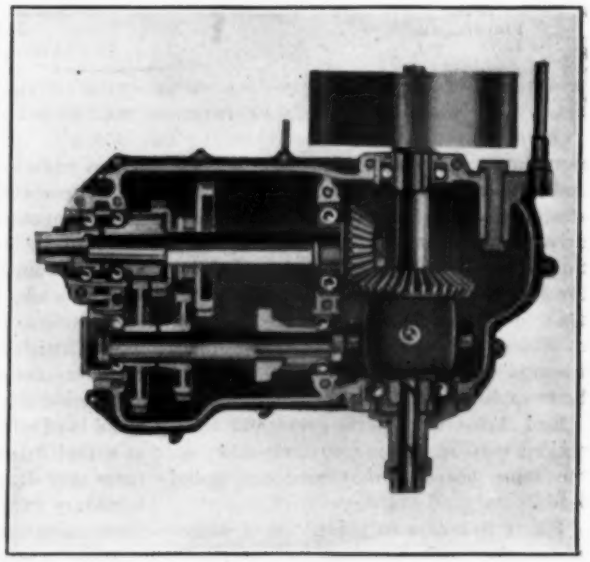


FIG. 4. ILLUSTRATION OF ONE BEARING USED FOR BOTH THRUST AND RADIAL LOADS

the case and with them the shafts, etc.

Fig. 2 is a fairly typical example of good French practice, of a correctly mounted 25 horse-power direct-drive three-speed gear. The end of the driven shaft is ball journaled in the drive shaft, which is the reason for the rather large bearing carrying the inner end of the drive shaft. Bronze bushes at this point are also frequently used, but their greater wear influences unfavorably the action of the nearer gear pair.

Fig. 3, a German 30 horse-power gear, is, as to mounting, fairly like the preceding one, and employs no containers. A rather smaller bearing for the inner end of the drive shaft is made possible by mounting this farther back, instead of directly over the small bearing inside the clutches. This does not admit quite as good bearing conditions as the drive gear is overhung, whereas in Fig. 2 this gear is supported between bearings.

End thrust from bevel gears and bevel pinions may be, and is frequently taken on the same bearings that take the radial loads.

Fig. 4 is a case in point. As a matter of course, such bearings are relatively heavier, since one pound of end thrust is the equivalent of from three to four pounds of radial load in its effect on the bearing. The bearing directly behind the differential box that takes the bevel-gear thrust is therefore considerably larger than that supporting the other end that carries radial load only.

Space considerations sometimes make it undesirable to use a bearing sufficiently large to take both thrust and radial load. In Fig. 5 the bearings directly behind the bevels are, as regards their outer races, free endwise, and therefore receive no thrust. Similar bearings directly behind them are, however, as to their outer races, bound endwise, so taking thrust, but free circumferentially, so that no radial load can be imposed on them. A good example of similarly separated radial and thrust loading from French practice is shown in Fig. 7, while Fig. 8 is taken from English practice. A tendency characteristic of much British engineering is evident in the relatively large parts used. The bearing supporting the inner end of the bevel-gear spool is of quite unusual dimensions. That is a fault to which the bearing manufacturer may draw attention as involving unnecessary expense, but which he is hardly likely to seriously oppose.

Many engineers prefer to take the thrust of bevel gears on ball bearings of the collar type—a practice which is certainly good. Fig. 6 is an example. The thrust bearing is mounted directly behind the bevel pinion. Alternative mountings are shown above and below the center line. Above, the spherically faced adjusting surface for the stationary plate is machined directly into the case; below, a concaved washer is employed, as giving rather simpler shop work. Alternative mountings for the differential shaft are also indicated on opposite sides of the center line. In one a smaller thrust bearing can be employed, carrying that on the shaft, as against a larger bearing demanded by the mounting on the bevel gear hub; this last mounting, however, is rather simpler, mechanically.

The various modifications of mountings likely to occur in practice have been fairly covered by those shown, so that I shall now take up the size selection.

Since, as has been previously stated, size selection is based on experience rather than on mathematical deductions from insufficient premises, this chapter will be confined to giving in simple diagrammatic form, recommendations of suitable bearings for various typical gear arrangements. Obviously, it would not be proper, since much matter is submitted confidentially for our advice, to give actual practice. The examples are, therefore,

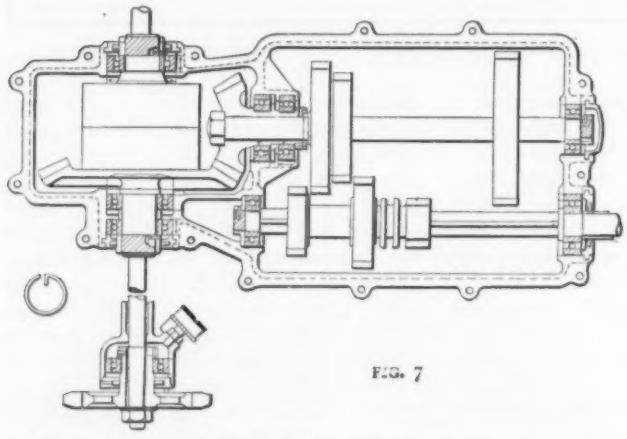


FIG. 7

A FRENCH EXAMPLE OF SEPARATE THRUST AND RADIAL LOADING

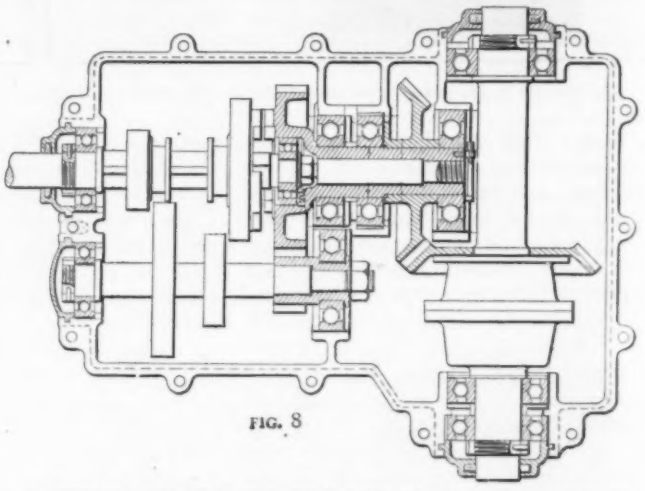


FIG. 8

AN ENGLISH EXAMPLE OF SEPARATE THRUST AND RADIAL LOADING

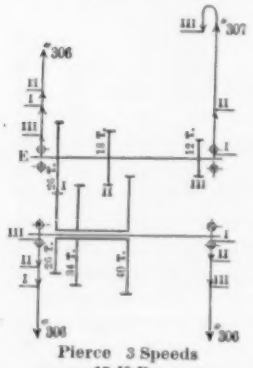


FIG. 9

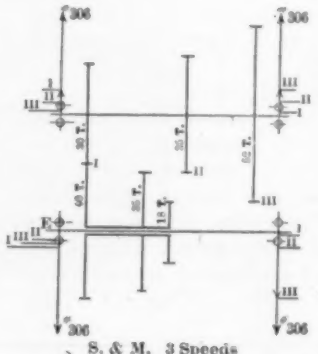


FIG. 10

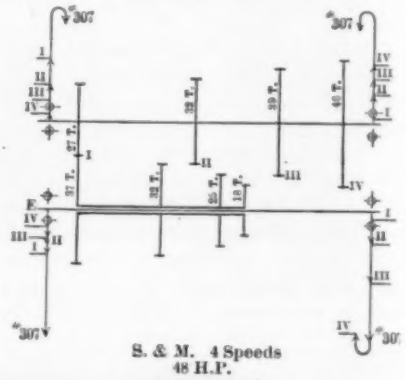
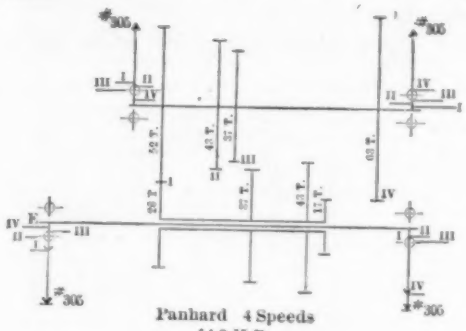


FIG. 11

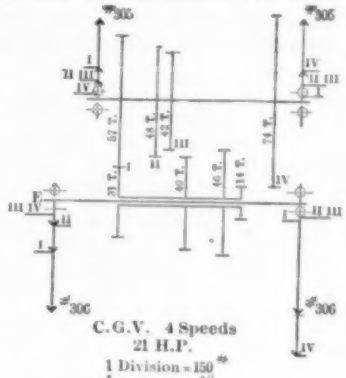
RECOMMENDATIONS OF BEARINGS FOR VARIOUS TYPICAL GEAR ARRANGEMENTS, GIVEN IN DIAGRAMMATIC FORM

taken from résumés of gear arrangements in the *Horseless Age* and other periodicals, and hence of general knowledge. The names given with each example are those given in the publications. In arriving at the loads imposed on the bearings, no attempt has been made to take into consideration change of engine speed with different gear sets in engagement, but bearing size suggestions are all based on an assumed engine speed of 1000 revolutions per minute to develop the horsepower cited. Journal-load figures and bearing sizes may, therefore, be modified by direct proportion for other powers or speeds.



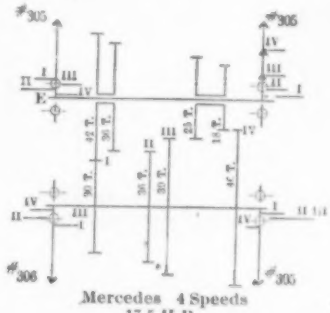
Panhard 4 Speeds
14.3 H.P.
1 Division = 150 #
1 " = 1"

FIG. 12



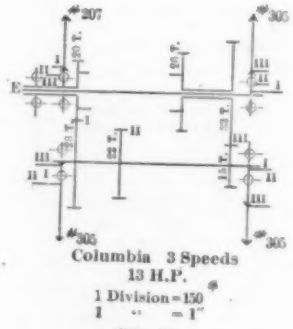
C.G.V. 4 Speeds
21 H.P.
1 Division = 150 #
1 " = 1"

FIG. 13



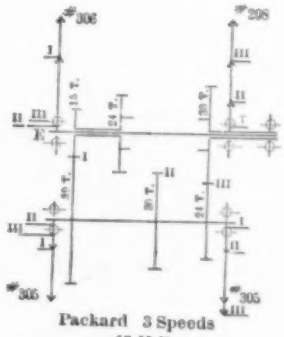
Mercedes 4 Speeds
17.5 H.P.
1 Division = 150 #
1 " = 1"

FIG. 14



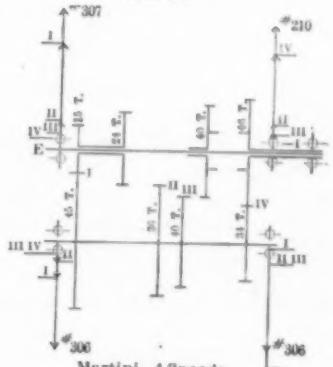
Columbia 3 Speeds
13 H.P.
1 Division = 150 #
1 " = 1"

FIG. 15



Packard 3 Speeds
17 H.P.
1 Division = 150 #
1 " = 1"

FIG. 16



Martini 4 Speeds
23 H.P.
1 Division = 150 #
1 " = 1"

FIG. 17

OTHER DIAGRAMMATIC RECOMMENDATIONS

Fig. 9 is a three-speed gear, with a three-gear slider. The slider spool is indicated by the shaft passing through it. The center distances of the shafts as well as those between the gears and bearings are to scale.

Each gear pair is given a Roman numeral, as I, II, III.

The journal loads at the bearings for each drive are plotted vertically over each journal to a scale of one division equal 150 pounds.

Light arrow points marked with the same Roman numerals show the amount of each load. Solid arrow points with numbers as 306, 307, give the rated steady load and speed tabular capacity of the bearings known by corresponding number symbols.

A glance will show the relationship of imposed loads to bearing rating. In some cases bearing choice has been governed by shaft sizes and arrangement of parts rather than by loads, which accounts for some variations in selection. Occasionally the length of a load line would extend beyond the confines of the slide; it is then bent over and the true length is the total of the parallel portions.

E indicates the engine or driving end.

Considering the values of Fig. 9 we see that with the 26—26 tooth gear pair I in engagement, the upper left-hand bearing is loaded to the amount of arrow point *I*, which is about half the tabular steady load and speed capacity of bearing 306.

The load on the bearing at the other end of the upper shaft, due to this gear pair, is very small, and indicated on the diagram as I at that bearing. On the lower shaft also the loads are well within the bearing ratings. The heavier loads on each journal are, counting from the top left to top right, to bottom left to bottom right, due to gear pairs II, III, I and III. With one exception these approximate one-half the rated bearing capacity. The exception is the two-speed gear III load in the upper right-hand bearing, which somewhat exceeds the bearing rating. A similar condition is not unusual, as for instance, on Figs. 11, 13, 16, etc. The conclusion must not be drawn that the other bearings are decidedly large, but rather that the relatively little use of this gear pair, coupled with a slowing down of the engine and consequent reduction of actual piston pressure, favors this particular journal. Actual overloads to produce ball crushing are not to be expected of any bearing that is likely to be demanded by consideration of shaft size, etc., remembering that bearings of the medium-weight series are usual for gear boxes unless abnormally large bearings are demanded by peculiarities of the mechanism, in which case the light-weight series comes under consideration.

In the three-speed gear of Fig. 10, it is apparent that shaft dimensions have called for bearings having relatively larger factors as compared with the loads imposed.

The four-speed gear of Fig. 11 follows the previous Fig. 9, in that the bearing values are about double the loads with the exception of the slow-speed load that shows up higher than the bearing rating.

In the four-speed set of Fig. 12 all of the loads are well within the bearing capacities demanded by shaft diameters.

Fig. 13 is another example confirming the previous ones.

Fig. 14 has two sliding gear sets for four speeds. The bearings demanded by the shafts are all well above the loads, including even the slow-speed load. The fact that all bearings may be of the same size is a distinct shop advantage, not counterbalanced by higher first cost of bearings, since, even though a size smaller for one or the other might be worked in, the difference in cost of these smaller bearings is inconsiderable.

A first example of a direct-drive jaw engaging gear with one slider is this Fig.

15. This is the first deviation from the general practice of employing bearings of the medium-weight series, two from the light-weight series, No. 207, carrying the engine and spool; their larger bore is demanded by the necessity for size due to the drive shaft being journaled in the spool. Approximately, bearings having the same outside diameter in the two series may be used interchangeably; thus bearing No. 305 used on the other journals has an outside diameter of 72 millimeters, and a rating of 620 pounds as against No. 207, of 72 millimeters and 600 pounds; but the larger bore of 35 millimeters of 207, as compared with the 25 millimeters of 305, adapts it for use on the spool.

comparatively small bearing of the light-weight series, No. 206, is quite ample for the outboard journal of the driving shaft—the upper left-hand one. If, however, any unbalanced couplings or other elements are carried near this, a bearing of corresponding bore of the medium-weight series, as No. 306, should be substituted.

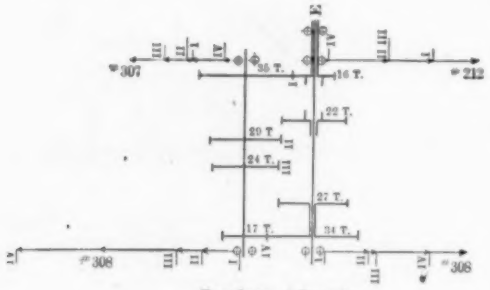
As the spur-gear part of Fig. 21 is along substantially the same lines as the previous examples, the bevel gearing only need be referred to. The thin direction arrows at the bearing below the bevel gear show that this is subject to radial load as well as the outward thrust of the gear, and also so mounted as to restrain the bevel gear against meshing too deeply. The magnitude of the thrust is measured

two for Fig. 22, and about one and one-quarter for Fig. 23.

While similar records of experience may be collated for bearings of any type, whether ball, roller or plain, it must not be overlooked that this is a record of experience, and can therefore be applied, as regards sizes and all quantitive relations, only to the bearings in question, which were all either D.W.F. or H.B.

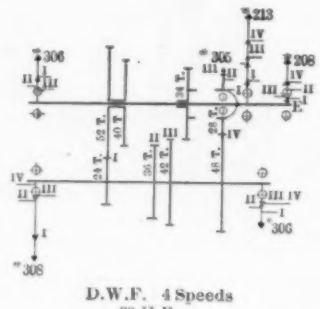
Similar records of actual experience with every form of ball or roller bearing in use have been carefully collated and the lessons drawn utilized along with these from the D.W.F. to aid my keeping up a steady advance in this highly specialized field.

The journal loads given in the various



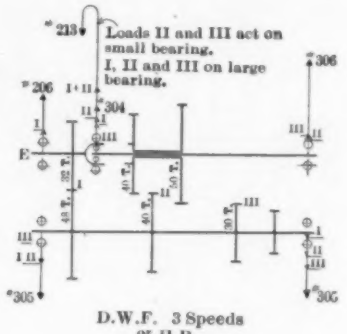
Peerless 4 Speeds
20 H.P.
1 Division = 150″
1 " = 1″

FIG. 18



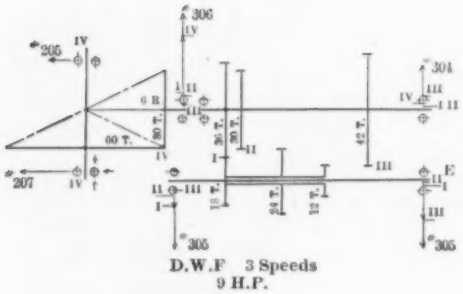
D.W.F. 4 Speeds
30 H.P.
1 Division = 300″
1 " = 1″

FIG. 19



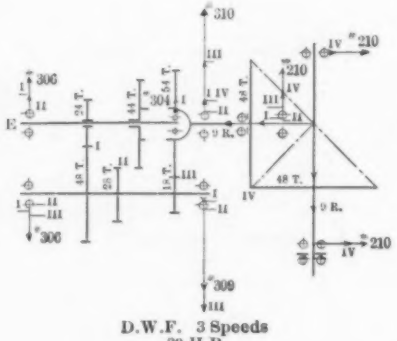
D.W.F. 3 Speeds
25 H.P.
1 Division = 150″
1 " = 1″

FIG. 20



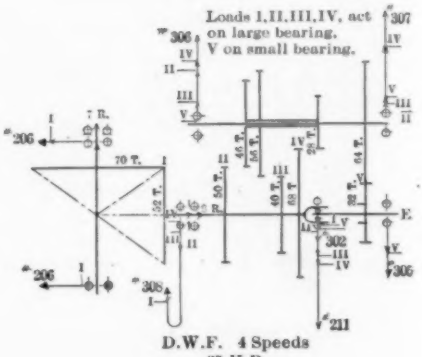
D.W.F 3 Speeds
9 H.P.
1 Division = 150″
1 " = 1″

FIG. 21



D.W.F. 3 Speeds
30 H.P.
1 Division = 300″
1 " = 1″

FIG. 22



D.W.F. 4 Speeds
25 H.P.
1 Division = 150″
1 " = 1″

FIG. 23

SIX MORE GRAPHICAL RECOMMENDATIONS

No. 207 will probably work in best also on the farther end of the spool, and will be ample as its location subjects it to smaller loads.

This succeeding example, Fig. 16, confirms the previous ones, as do also Figs. 17 and 18.

Fig. 19 is the first example of ball-bearing use for the inner end of the drive shaft, where it is journaled in the engine-shaft end. Rather restricted space consideration will naturally lead to the conclusion that this bearing (No. 305) would be relatively more heavily loaded, still, under the maximum condition due to gear set III—the second fastest—such load is within the bearing rating.

This is true also for Fig. 20. Here a

from the shaft intersection to the arrow point. Remembering that one pound of thrust is the equivalent of three pounds radial load on a bearing of the radial type, an addition (not indicated) of four times the thrust length to the maximum radial load IV shows that the capacity of No. 207 is pretty well used up. Personally, I should prefer No. 307 to the 207 used in the German example.

The thrust of the bevel pinion is taken on a collar bearing 6-*R*, which, as is shown by the arrow on the thrust line, has a factor rather better than two at the speed in question.

Figs. 22 and 23 are also bevel-gear sets, in which the thrust bearings of the collar type have factors slightly less than

preceding examples are readily enough derived by calculation from a determination of the tooth pressure at each gear pair or torque at the gear radius required to transmit the horse-power at the speed in question, this in turn resolved into loads on the shafts at the centers of the gear faces in inverse proportion to the gear radii and these again divided between the shaft journals in inverse proportion to the distances from the journal center to the gears. Yet, a graphic determination of these factors has the advantage of simplicity of checking the intermediate steps, of proving the latter automatically, and of permitting the direct transference of the results with a pair of dividers to the journal diagrams.

In Fig. 24 one gear pair and the four journal locations of the two shafts are shown to scale. The pitch-line torque L is laid off below to the desired scale; a vertical M, corresponding to the gear radius, is laid off at one end of L upward, and the pinion radius N downward at the other end of L. A diagonal connecting the extremities of M and N will intersect L and divide it into two portions P and Q that give the loads at the shafts.

Taking the lever arm A of load Q to the journal, and erecting this as a perpendicular upward from the intersection of L just found, then dropping the lever arm B perpendicularly from the extremities of L, and connecting by diagonals, will give intersections dividing load P into 1 and 2, acting on the bearings of the lower shafts and 3 and 4 acting on the bearings of the upper shafts.

If the torque L has been calculated correctly, all subsequent steps prove up, since the sum of the four loads must equal the original torque.

The graphic determination of radial and thrust loads is given in Fig. 25.

The calculated pitch-line torque L is laid off to scale in a direction normal to the pitch line. Lines parallel to the shaft are laid off from the extremities of L. From their intersection a perpendicular to L is drawn. From the meeting point parallels to the shaft are drawn. The resultants 1 and 2 are respectively the radial and thrust loads of the pinion, and are transferred with the dividers to the gear diagram.

Distances 3 and 4 relate to the bevel gear respectively as thrust and radial load.

The thrust loads on the bearings are not affected by the location of the bearings along the shaft. The radial loads found act on the shafts at the point indicated by the largest pitch radii as shown. (Strictly, this is modified by the length of the gear teeth and their accuracy of contact. Theoretically, the correct point of average torque is about one-third of the tooth length inward. As all results are merely comparative, this deviation from strict truth gives greater simplicity and does not alter comparative results.)

The division of these loads into radial loads acting on the journals is graphically accomplished in the same way as explained in connection with Fig. 24.

As there are present many users of ball bearings, and they no doubt will agree with me that their several interests can best be served by the fullest possible consideration of, not only their individual experience, but of that in connection with the experience of others, I sincerely trust that they will favor me with their observations, so that I may in future, as I have in the past, analyze and compare them and draw conclusions and make these available to all, though, of course, regarding the individual communications as confidential.

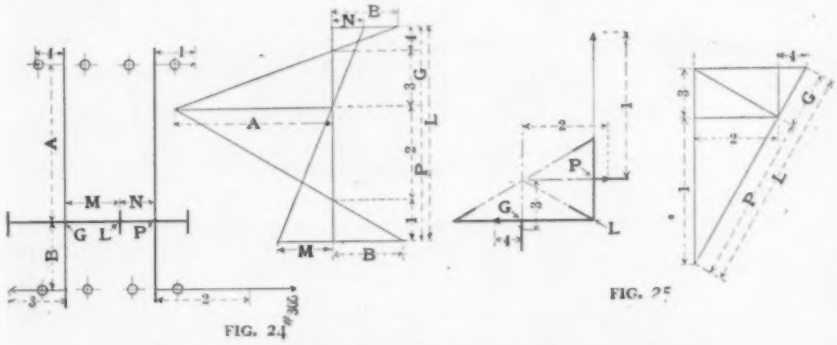


FIG. 24 FIG. 25

GRAPHICAL DETERMINATION OF RADIAL AND THRUST LOADS

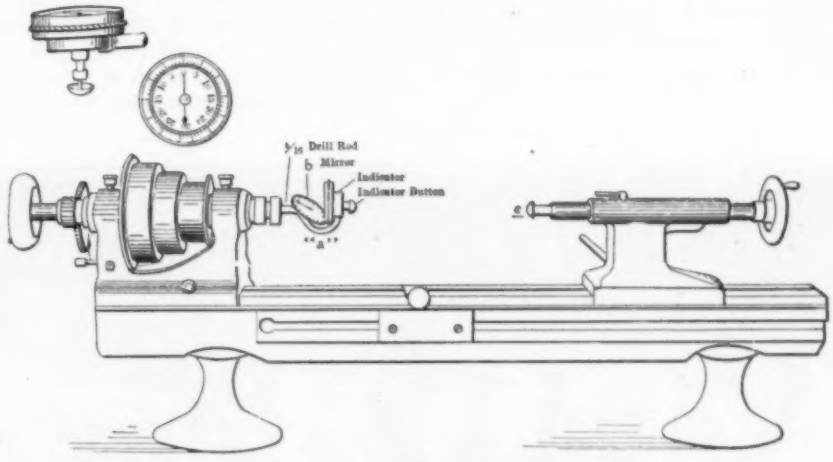
Vice-Consul H. M. Byington advises that in November the Egyptian Mail Steamship Company will institute a weekly service of steamers between Naples and Alexandria, and Marseille and Alexandria. Two new 21-knot steamships are provided which will make the trip in three days, and will be of benefit to passengers and shippers of quick delivery freight to Alexandria.

Only three minutes and five seconds' time was required to haul apart the steamship *Allianca*, of the Panama Railroad Company's fleet at Cramp's shipyard, Philadelphia, where she is to be lengthened 36 feet. Placed on the dock the ship's hull was divided immediately forward of the boilers.

Another Dial Measuring Machine

By Ethan Viall

The reading of Oscar Perrigo's excellent article on page 226 under the above title, reminded me of a measuring device that I saw used in a Chicago jobbing shop, about six months ago. The proprietor of the shop told me that a year before he had had a lot of small articles to get out, which had to be finished within very narrow limits. As the use of micrometers was in this case so slow and bunglesome as to be very unprofitable, he cast about for some quick and accurate method of measurement and hit upon the following device. This proved so satisfactory that it has been in constant use since.



AN IMPROVISED DIAL MEASURING MACHINE

It required the making of but three things besides what they already had on hand and less that a half-day's time was spent in rigging up the whole thing. When complete it could be dismantled in half a minute and the parts used as originally intended.

The parts used were a small precision bench lathe, a Starrett dial test indicator, a small mirror, and the parts made were a special tailstock center, a special indicator holder for the spindle and a wire clip for the mirror; a combination that can be turned out of hundreds of shops on short notice.

The tailstock center *e* was made the same as a regular center except it had a hardened "button" on the end in place of the usual points. After this center was turned and hardened, a small piece of brass was put in the chuck and a cap hollowed out in it. Oil and flour emery were put in this, the tailstock run up and the button on the center lapped smooth.

The indicator holder *a* was made of a piece of five-sixteenths drill rod, bent as shown, one end fitting with the draw-in chuck of the lathe and the other end flattened slightly and secured into the dial indicator, using the screw holes already in the instrument. This holder was bent so

as to bring the button on the bottom of the indicator approximately central. Another test indicator was now brought into use, the lathe spindle rotated and the button carefully turned up by bending the drill rod. This practically finished the machine except that the position of the dial face made it difficult to read, so a small round mirror *b* was fastened 45 degrees to the face, with a wire clip. The result was the same as if the dial itself was up, for the dial being numbered each way from zero, the reflection caused no confusion.

Where no standard rods of the length wanted were at hand, the buttons were set the proper distance apart by the use of an inside micrometer, the hand on the dial being brought to zero by adjusting the tailstock spindle.

The range of measurement of the indicator itself, which was a regular Starrett, was ⅛ inch, or 1/16 inch each way, reading by half thousandths, and the lathe bed was long enough to allow an object nearly two feet long to be measured, so one can readily see that this device has a wide field of usefulness and is sufficiently accurate for all ordinary purposes. When in use as a measuring machine the lathe spindle is locked in the manner common to precision lathes.

Of course there are a number of other ways that this could have been made, but that isn't the point; the way I have described was the way it was actually made, using only what the man already had in his shop.

Lunch Association of the Rock Island Arsenal

By A. D. Knauel

It is nearly a year now since the Rock Island noon-hour lunch association has been in existence. Starting as an experiment accommodating only about 200 men at first, it has now reached a stage that may safely be called a success, as over 650 men sit at the table daily. This means that 650 men must be fed every day in the 20 minutes following 12 o'clock noon.

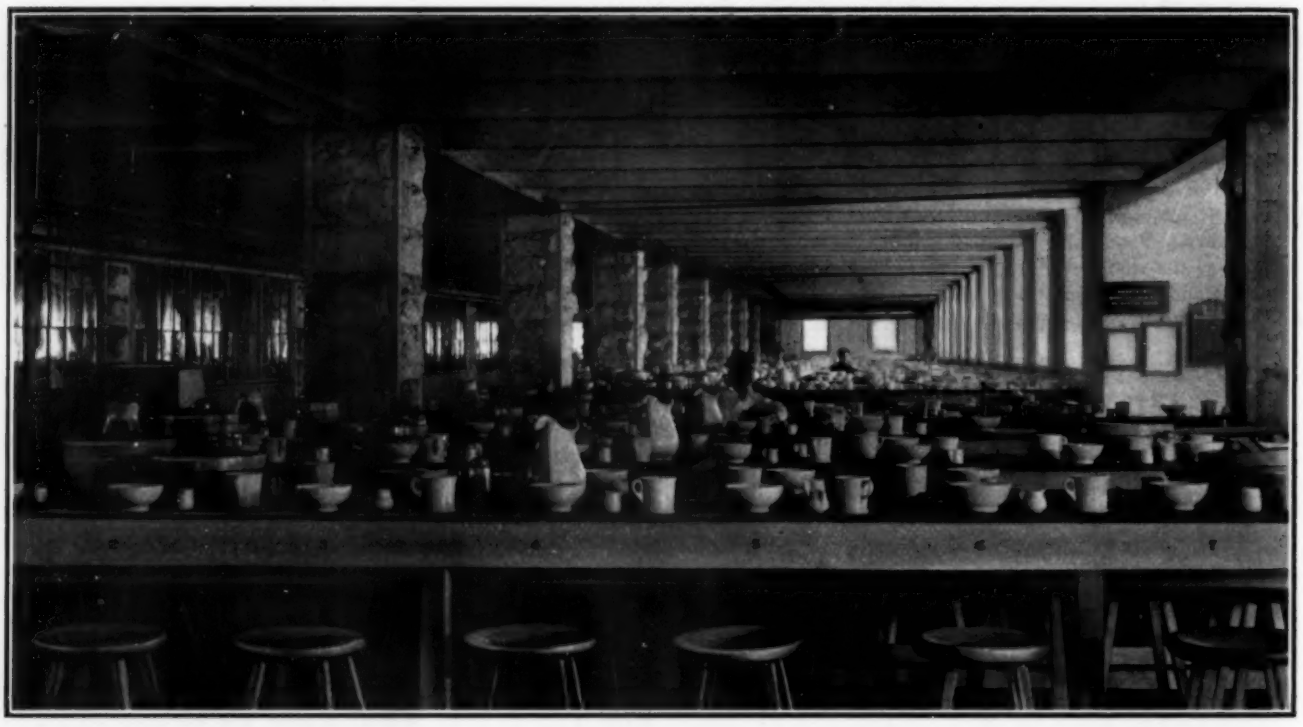
At first some little trouble was experienced to find the proper menu to serve, for constant change of food is daily required so as not to pall on the appetite. For instance, here is a bill of fare for a week: Monday, oyster soup and crackers; Tuesday, boiled beef and potatoes; Wednesday, vegetable soup and crackers; Thursday, veal stew; Friday, tomato soup and crackers; Saturday, corned-beef hash.

Bread and butter, milk or coffee are abundantly served at every meal. There are variations from the foregoing order of fare, such as fresh pork sausages, baked beans with pork, corned beef with cabbage, etc.; salt, pepper, catsup and mustard are on the table to suit the meal. Meals are served at 10c. straight and the association is not managed for profit or to accumulate a surplus, except a fund of several hundred dollars to meet current accounts and to maintain equipment.

The association pays no rent. The average cost of help comes to $76.50 per week for four men and four boys. The first expense of equipping the kitchen and dining room was partially paid for by the Government. Dishes and breakages are paid for out of the initiation fee of 75 cents charged each member. Dining-room expense, that is, supplies for dining room and kitchen, such as laundry and cleaning material, averages $50 a month. Cost of provisions has averaged for the last six months about $1018 a month; of this amount the largest items are meat, bread, butter and milk averaging about $45 per week.

Since the association has been formed it has accumulated quite an amount of property, such as a power dish washer and a power coffee grinder, a bread cutter, vegetable shredder; a large four-unit hotel range is at present being installed.

Only employees of this arsenal may become members of the lunch association. The association is self governing in so far that the commanding officer passes his final approval on all actions of the different committees. The administration of the association consists of the elective officers of president, first and second vice-presidents, secretary and treasurer, whose duties are obvious, and four committees who perform their duties without monetary consideration: Executive committee, in general charge of affairs; purchasing committee, consisting of four members who purchase all supplies and provisions; auditing committee, consisting of five members who audit the secretary's and treasurer's books once each month and also audit each bill of goods weekly, be-



LUNCH ROOM OF ROCK ISLAND ARSENAL LUNCH ASSOCIATION

fore the bill is paid; dining-room committee, consisting of three members who have charge of dining room, as to its cleanliness and conduct of men at the table, make out the bill of fare for each meal and have charge of the help.

A limited ticket is issued semi-monthly, with dates of meals printed on margin. These dates are punched by one of the dining-room committee when the men are seated at the tables. Tickets are paid for in advance.

Fig. 1 shows a section of the dining room, which occupies the entire west and south bays of one of the large shop buildings.

The advantages of a hot lunch over the cold victuals of a dinner pail are very much appreciated by the men, for everyone must carry his lunch on account of the distance of the shops from town, street cars running only morning and evening. To the unceasing efforts of the commanding officer and of the workmen who have given freely of their time the success of the Rock Island Arsenal Lunch Association can be credited.

A sick-benefit association in a flourishing condition is also conducted among the employees of this arsenal.

The largest labor organization in the world is according to a recent industrial report the Deutscher Metallarbeiterverband-German Metal Workers' Union. At the close of 1906 the membership was 335,075 and during the past year funds collected amounted to $1,880,000.

Molding Curved Pipe in Dry Sand

By C. D.

Making cast-iron pipe is a work which, while not so difficult as some machinery castings, still has many problems which daily confront the pipemaker. As nearly all the pipes are inspected and tested to 300 pounds pressure, and no pipe accepted where the thickness of metal is ⅛ inch thinner than the thickness required by the specifications and drawings, it keeps the foundry foreman busy if he desires to keep the loss to a minimum.

Pipe specials must pass through the same inspection as straight-pipe, with the exception of the pressure test. All castings must be free from sand holes, blow holes, cold-shut cracks and other defects, and no plugging or filling will be allowed. No special casting will be received where the weight is over 5 per cent. less than the standard weight, and not more than 5 per cent. in excess of the standard weight will be paid for.

These specials are made in green sand, dry sand and loam. The making of a curved pipe, vertically, in dry sand requires accurate rigging and may be of interest to some of the readers of the American Machinist. These curves run from 20 to 48 inches inside diameter and six feet long, 15 feet radius, 11/16 to 1½-inch metal. The entire rigging, with the exception of the curved pattern, is made of cast iron, the pattern being made of wood.

Molding Pipe

The molding is proceeded with in the following manner: Sand is rammed in the recess of the seat *A*, Fig. 1, struck off and slicked; the seat is then placed on the angle bracket *B*, the bell pattern *C* is placed in position, the taper at the bottom being machined to fit the taper in the seat *A*; parting sand is thrown on the sand in the seat and the bottom flask head *D* is placed in position and brought central by two pins in the seat. The bell is then rammed up to its hight and the curve pattern *F* is set on the bell *C*, the taper *E* at the bottom end of the pattern fitting into the bell pattern *C*. A nail is placed in the sand on the center of the inside curve; this is used in setting the core. The entire flask sections are split on the lines *G* and are placed on top of one another and clamped as the ramming continues. When the full length is rammed up, an iron bead ring *H* is bedded in and rammed solid. This ring forms the print which receives the covering core.

Curved Pattern

The curve pattern *F* has a slot at the upper end through which the draw bolt *I* passes and which allows the pattern to follow the radius as it is drawn from the sand. The bead ring *H* is held down while the curved pattern is being drawn, to prevent the mold from tearing up. The

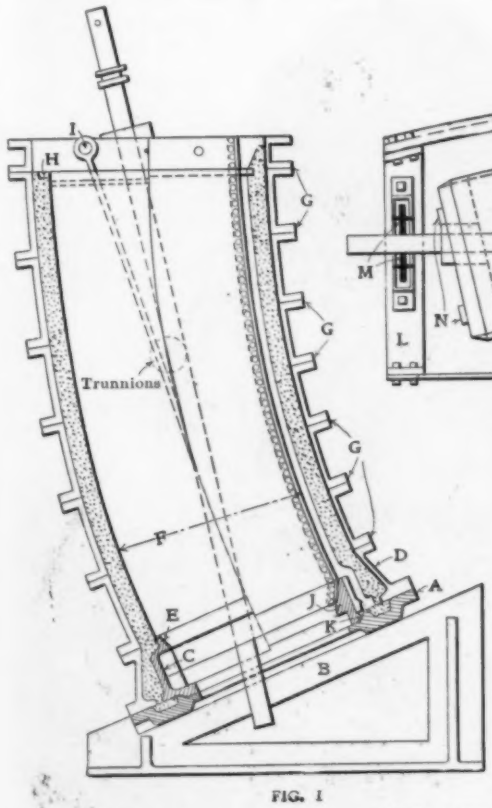


FIG. 1

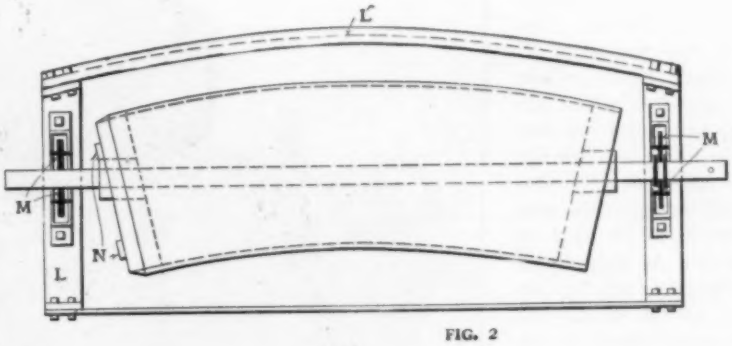
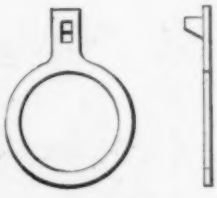
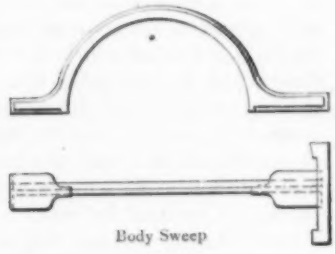


FIG. 2



Seat Sweep

FIG. 3



Body Sweep

FIG. 4

MOLD, CORE FRAME AND SWEEPS USED FOR CURVED PIPE

clamps at the seat are knocked off, the mold lifted off the seat *A* and the bell pattern *C* dropped out. The mold is then dressed, blacked and slicked. The core *J* forms the socket of the bell. This is built on a cast-iron ring which is machined to fit the taper *K* in the seat and also fit in the socket core box; the ring is clay washed, placed on a revolving table, small hay or hemp rope run around the outside, the core box, split in two, is placed around the ring, clamped and rammed up. The box is then drawn away, the core is sprinkled with molasses water and placed in the seat. The core and seat are then blacked, the mold lowered on the seat and clamped, and the mold is ready for the oven.

Sweeping Core

The core frame *L*, Fig. 2, is placed on strong trestles and leveled up. The core spindle is run on roller bearings *M*, the center of the spindle being in line with the top of the frame on which the sweep rides. Oblong bolt holes are cast in the end pieces of the frame to allow the spindle to be adjusted sideways. One spindle end has lugs *N* on which the seat sweep rides. The spindle is adjusted so that the seat sweep meets the body sweep at all points; three-fourths inch hay or straw rope is then run on the spindle and clay rubbed on, after which the first coat of mud is swept on, the spindle being reversed, as only one-half the core can be swept at a time. It is then placed in the oven and dried and the second coat swept on in the same manner as the first. It is again placed in the oven, partly dried and then blocked, after which it is placed in the oven to be thoroughly dried. Before the core is taken off the frame a mark is made on the center of the inside curve at the bottom end, and this mark meets a corresponding mark in the mold for the purpose of locating the core.

When coring up, two I-beams, having bearings bolted in their center, are laid parallel on strong trestles.

Setting Core

The mold is supported on these bearings by trunnions bolted to the flask. A block and fall attached to the lower part of the flask is used to pull the mold over to the same angle as the core when it is about to enter and is gradually let back until the core is entered in the socket ring.

After the main core is in, the mold is again set on the angle brackets, the core centered at the top and measurements taken at four points. The covering core *O*, Fig. 1, is placed on and the runner built, after which the main core is keyed at the four places where the measurements had been taken. The mold is now ready to be poured.

Two men can run up a 30-inch curve mold and core it in 15 hours, or a total of 30 hours. In keying the core, care is taken to key iron to iron. This method has worked very successfully, and the loss is very little.

A Motor-driven Lathe Carriage

By John Riddell*

The moving of the carriage on a large lathe such as the 42-inch Pond lathe, due to the weight and low position of hand wheel becomes a very laborious job, especially when it has to be moved any considerable distance along the bed of the lathe. It is not only hard on the operator, but also consumes a great deal of his time.

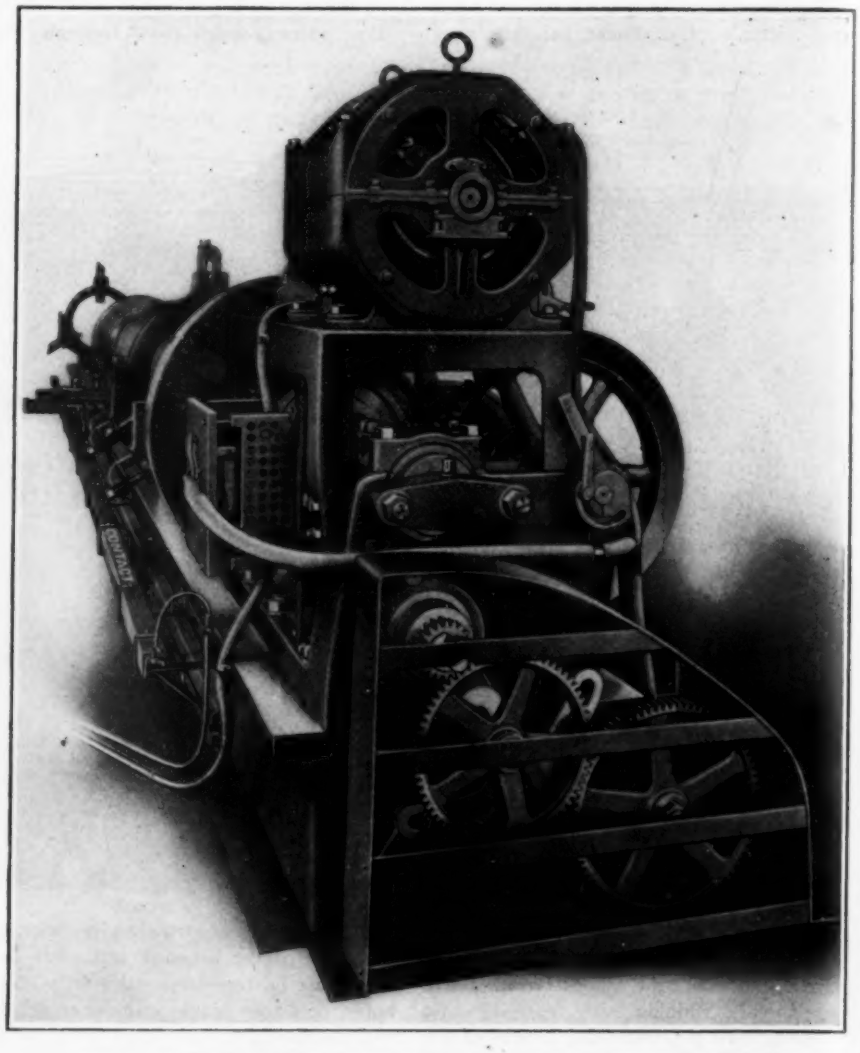


FIG. 1. MOTOR-DRIVEN POND LATHE SHOWING CONTACT BAR AT THE BACK

To overcome this, the motor drive shown in Fig. 2 was designed. As the load on the motor is practically constant, as well as to avoid the use of starting boxes or controllers, a series-wound motor was used, as this gives practically full speed and power at once. Current is supplied through sliding a contact on back of lathe carriage, thence through an armored cable, which can be seen in Fig. 2, partially concealed in one of the front T-slots and supported on the inside of the carriage.

The contact at the rear of the lathe bed consists of an angle iron running the full length of the bed, supported by brackets as shown, and having on the under and inner side a flat copper strip, thoroughly insulated from the angle iron, as can be seen in Fig. 1.

The starting device consists of a double-throw switch located in the five-sided box shown at the lower right-hand corner of the lathe carriage, and is operated by the lever shown. Throwing the lever to the right moves the carriage in that direction, and moving the lever to the left moves the carriage to the left.

By reason of the motor being connected direct to the gearing of the carriage, without the use of clutches, the armature is slowly revolved when the hand or power feed is used; but the small weight of the armature has at no time proved objectionable to the operators, nor is the use of

*Mechanical superintendent, Schenectady Works, General Electric Company.

the taper attachment in any way affected by the design of the angle-iron contact, as can be seen in Fig. 3.

In practice the gearing is all covered to prevent clogging with chips, and presents a very neat appearance. While primarily designed to relieve the operator from the slow and laborious task of moving the carriage from one point to another, the motor drive enables him to bring the tool to within a very small fraction of an inch of the point desired in a much smaller portion of time than by hand.

The addition of a power drive to any heavy part of a machine is a time and money saver, and pays in the quantity of work turned out. The moving of a heavy carriage is hard work, and a skilled machinist is not the man to be doing laborers' work in such a case as this.

Good and Bad Points on Machine-tool Design

By Mercury

I wish to draw the attention of readers of the American Machinist to this question: Why is it that if we take almost any particular machine tool we seem invariably to find that all the American models are of one type and the English ones of another, although all are used for precisely the same work and purpose?

If you see a photo of a machine tool, say a lathe, just made by a new firm, one glance is usually enough for you to be able to assert, with some certainty, the country in which it was produced. Now it would seem palpable to the ordinary person that there is something wrong here; the points in question have got beyond the experimental stage, the types are now standard, and yet we have two standards—two *bests* as it were!

If American and English lathes had evolved separately on different planets, this is only what we might have expected; but they have matured side by side, each nourished by men who have not only been constantly interchanging ideas, but even the very machines themselves are of course exchanged daily between the two nations. This being the case, one would most naturally think that as each new idea came out, it would be fully discussed, experimented upon, then tried in actual practice and, if thoroughly satisfactory, would then become universally standard.

But as a rule, nothing of the sort happens; a large Yankee firm, shall we say, designs a lathe, introducing into its construction some novelty which is treated with smiling contempt by all the other lathe *makers*, until the day comes when it is voted a great success by the *users;* then the American manufacturers wake up, metaphorically tuck up their shirt sleeves and each firm brings out a new model of its old lathe, embodying this new feature.

And the English lathe builders, aren't they copying this same good thing? No; strange to say, they are not; they are too busy imitating the little improvement that sold a big English firm such a lot of machines last year to have noticed the American move at all!

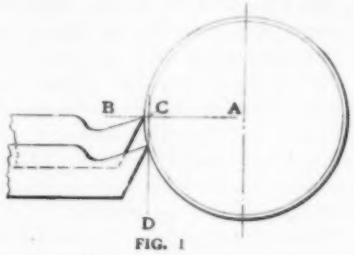


FIG. 1

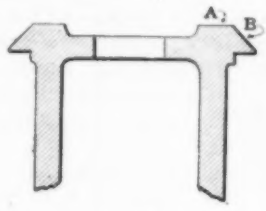


FIG. 2

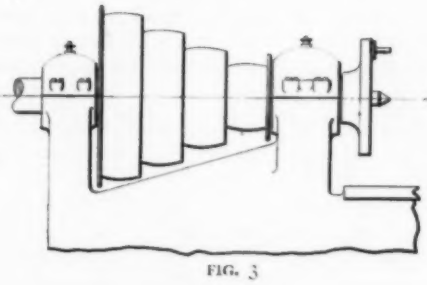


FIG. 3

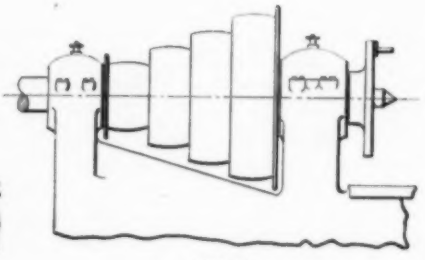


FIG. 4

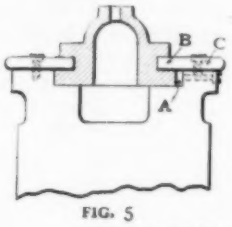


FIG. 5

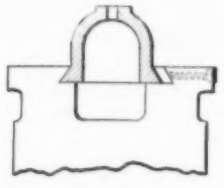


FIG. 6

GOOD AND BAD POINTS IN MACHINE TOOLS

Flat or V Lathe Beds

Now let us consider one or two of the

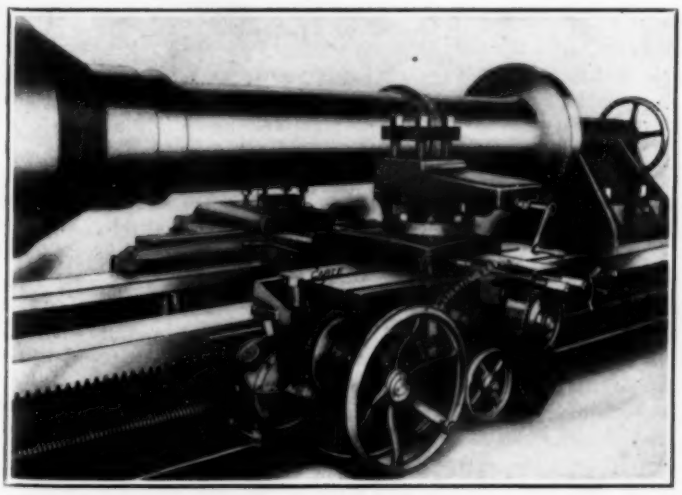


FIG. 2. CARRIAGE WITH MOTOR ATTACHED

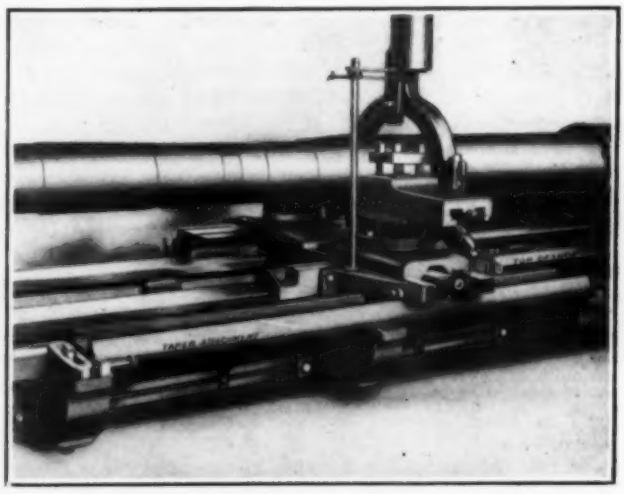


FIG. 3. TAPER ATTACHMENT DOES NOT INTERFERE

most striking instances that I have been speaking of. See how lovingly the English manufacturer seems to cling to the old square type of lathe bed instead of adopting the V type so universally used on American machines, and which is undoubtedly far superior for lathes up to 18-inch center. I see no reason why, if properly proportioned, it should not work equally well on the heavier machines.

In support of this question of superiority, let me refer to Fig. 1, which is intended to show the relative difference of effect on the cutting tool due to the wear on each type of bed.

With the square bed, the wear is almost entirely confined to one side of the square, with the result that the saddle, carrying the cutting tool, runs out away from the centers in a direct line, Fig. 1, from *A* to *B*; but in the V bed, although side wear does exist, yet the tendency is for wear to cause the saddle and with it of course the tool to drop in a straight line, Fig. 1, from *C* to *D*.

To take a single example, suppose a lathe 12 feet long, fitted with a square bed that has been used on heavy work from 2 feet in length downward continually for 12 months, has a job put in long enough to tax nearly its full capacity.

Now let us assume that the wear on the square bed is from 0.007 to 0.01 inch where the year's work has left its mark, that is to say, the tool will run away from the work that amount when passing over the worn part, the result being that the job will be tapered, one end being from 0.014 to 0.02 inch larger than the other, necessitating a lot of filing to get it correct.

As a contrast to this, let us imagine the same lathe to be fitted with V slides and given the same test; what will be the result? Assuming that the work in question is a bar of 2-inch diameter and allowing a very wide margin for side wear, the saddle would actually have to drop a distance of from 0.11 to 0.13 inch to obtain the same error that we got in the case of the square bed!

This is by no means all that can be said in favor of the V bed; another great point is that the chips fall off instead of getting under the saddle as they have such a tendency to do on the square bed. I have this fact brought before my notice very forcibly just lately by watching a couple of new capstan lathes that have been recently installed and which have beds of the section shown in Fig. 2. Although all reasonable care has been taken to prevent the chips from getting under the saddle, yet the flat portion *A* is scratched and worn considerably, while the part *B* is as good as the day it started work.

Lathe Headstocks

To take another instance, let us consider the lathe headstock with the inverted step cone, Fig. 3, as opposed to the older and usual type, Fig. 4. This improvement had got to the stage where one or two American firms (builders of small precision lathes) having had it in use for several years with excellent results, another large Yankee firm is now introducing it on milling machines and capstan lathes. This I hope is the beginning of the period when all the other firms will do likewise, because, as one can see with a single glance at the two types, the inverted cone allows the strongest bearing to be in front where it is most needed, instead of at the back. I am more than surprised to see the different makers turning out newly designed lathes with the old-style step cone, which should have been discarded ten years ago.

However, better late than never. I now hope for better times in this respect in spite of all the shouting about the step cone being a thing of the past; as a matter of fact, I think it *is*, as far as heavy machinery is concerned; but in my opinion it will have a long run yet on the smaller types.

Shaper Rams

To turn now to shaping machines, we find the same old story, but with the characters reversed! This time I think we shall find the English designers have a good point in their favor. I refer to the slide on the ram.

American practice is shown at Fig. 5, which consists of a square slide, the only adjustment for which is at the side at *A*; but no allowance is made to compensate for the wear, which is considerable at *B*, except the laborious method of taking off the plates *C* and scraping them.

Now the English shaper, which I much prefer as far as the ram is concerned, has a dovetailed slide, Fig. 6, and all wear is easily compensated for.

Of course some will immediately point out that the square is the strongest; while admitting that this is so, still I think experience will soon show that the dovetail will stand all the belts will drive. As a matter of fact, I tried the experiment of having a machine altered from the square to the dovetail, with the very best results; we found that the machine could take bigger cuts and with a broad finishing tool in, there was no chattering.

Special Tools for Screw-machine Work

Editorial Correspondence

The tool equipment for screw machines has changed quite as much as the machines themselves, and they are now handling a large variety of work in many shapes.

An out of the ordinary turning tool is shown in Fig. 1. The steel casting *A* is made to fit over three bars in different holes of the turret and is clamped to them as shown. The boring-tool body *B* carries the turning tools *C C* and is held in *A* by the screw *D*, which has a long taper point going through the shank

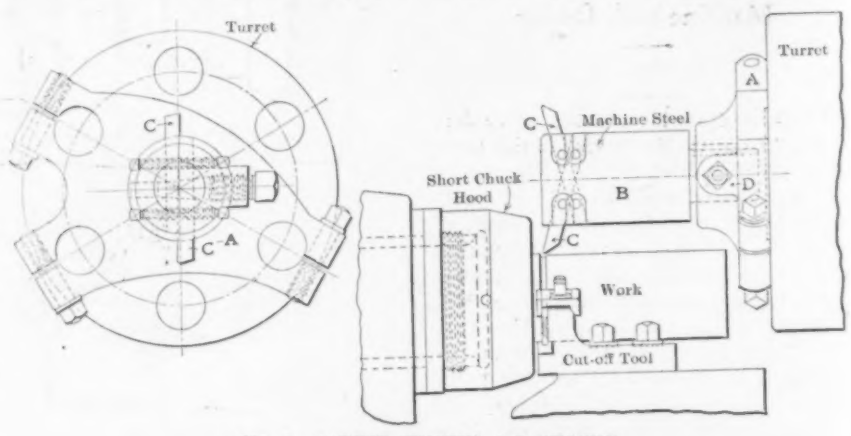


FIG. 1. OUTSIDE TURNING ATTACHMENT

and acting as a key to draw the tool solidly into place.

These are arranged so that one tool takes the roughing and the other the finishing cut, the turret being revolved half way to bring the desired tool into position. This is for turning 3¼-inch stock from the bar and is used instead of a box tool on this work. The cutting-off tool is shown in place.

A Trepanning Tool

What is known as a trepanning tool is shown in Fig. 2. The work and the tool in place are shown in the lower left-hand corner, while the details of the tool and the holder are given in full. The development of the outside of the tool-supporting ring shows how the tools are supported in place and also the oil holes which allow lubricant to be forced right to the cutting edge. There is also a hole through the shank and through the pilot reamer which keeps this supplied with oil.

The cutters are of round stock with the cutting end squared and ground for clearance, as shown in the detail, which also gives the dimensions. The pilot cuts on the end only, the spiral flutes simply

allowing the escape of chips and oil, and guides the whole tool.

Turning Eccentric Work

It sometimes happens that an eccentric body is wanted on a screw or stud, as shown at *A*, Fig. 3, and it is out of the question to re-chuck it as would be the case if only a few were to be made. The little attachment shown bolts to the cross slide, while the piece *E* with its strap *D* encircles the bearing ring *F* on the outside of the chuck *N*.

The ring *G* is turned with the same amount of eccentricity that is desired in the work *A*, and is fastened to the chuck by the small pointed set-screws, which go below the surface of the ring and out of the way of the roller *C*.

The tool *B* is controlled by the eccentric *G*, while the spring *L* keeps the roller *C* in contact with the eccentric. It makes a very simple device and one that can be used on a large variety of work, either eccentric or oval, by making the cam *G* of the proper outline.

Thread Rolling

One of the newest attachments for screw machines is the device for rolling threads, as shown in Fig. 4. This does not take the place of threading dies in ordinary work, but it allows both ends of a piece to be threaded at the same chucking and saves taking it out of the machine before it is done, combining what would ordinarily be two operations in one.

The work *O* is formed by the tool *E*, and tapped by the tap *F*, in the holder *G* in the usual way. Then the thread-roll holder *I*, which is fastened to the back of the cross slide as shown in the side view at the right, moves toward the work when the forming tool is withdrawn and the thread roll *H* passes under the work, rolling the thread on the back end of the work which could not be reached by a die.

After the thread roll passes clear of the work, the spring fingers *S* go over it and at the same time the cutting-off tool *K* cuts the piece from the bar. The forward movement of the cross slide forms the next piece, which has been pushed forward in the chuck, and the operation is repeated.

The threading roll is practically a nurl, running free on a stud, and is adjusted to or from the work by the set-screw. The spring fingers prevent the work falling or jamming, and the thread produced by the rolling process is equal in every way to one cut with a die. As the metal is forced up from the bottom of the threads, the outer diameter of the blank can be less than with a cut thread.

This attachment, as well as the others which have been illustrated, is made by the Cleveland Automatic Machine Company, Cleveland, O., which kindly furnished the drawings from which these illustrations are made. F. H. C.

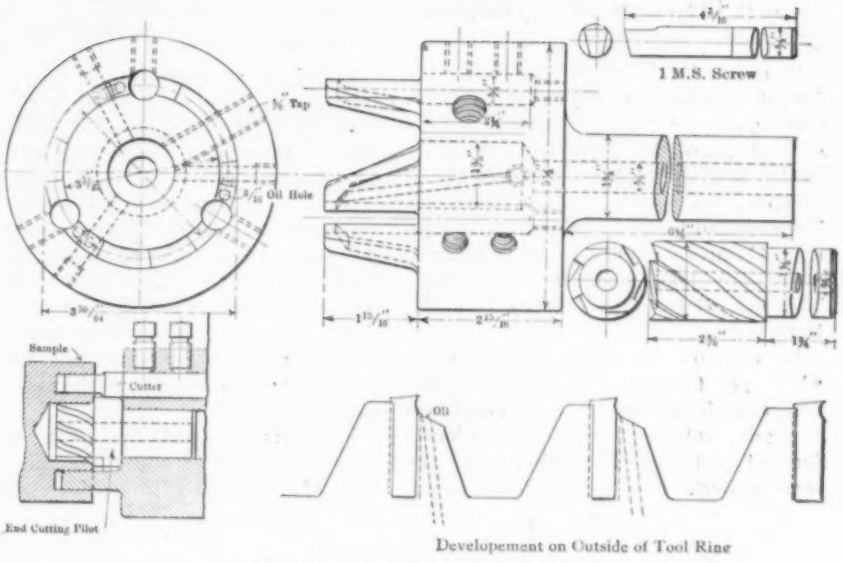


FIG. 2. TREPANNING TOOL HOLDER

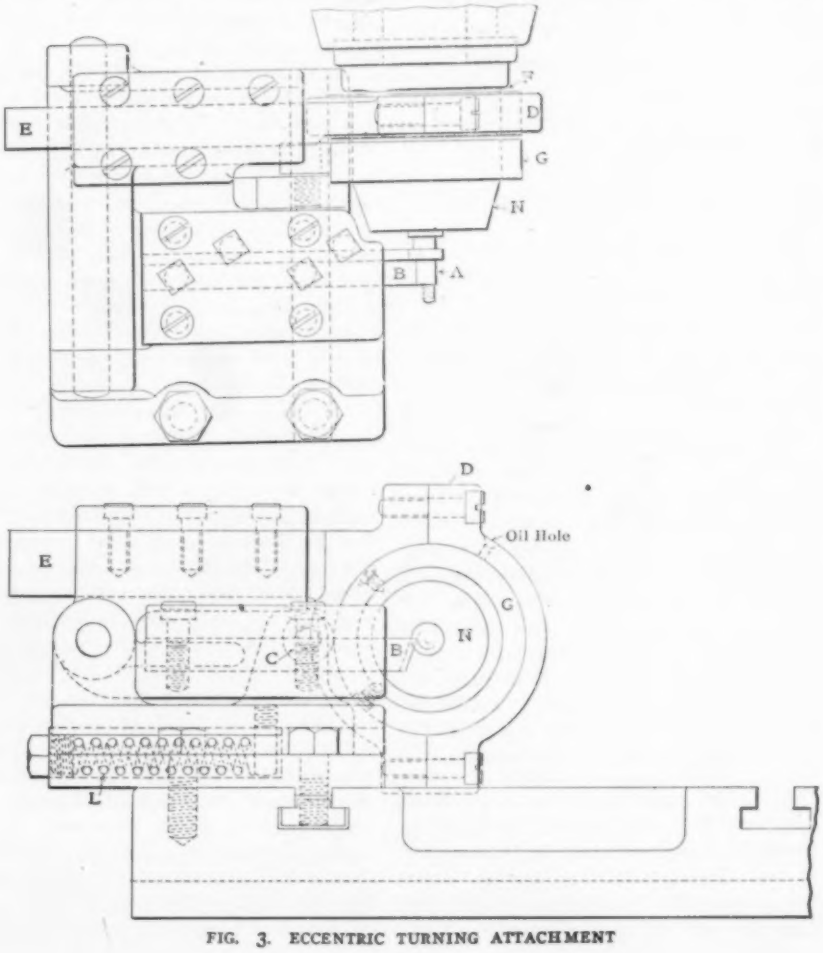


FIG. 3. ECCENTRIC TURNING ATTACHMENT

A plan of shop apprenticeship that is in operation in one large sheet metal workers' establishment in Philadelphia provides for a bonus to be paid to the apprentice upon the completion of his term of indenture. The apprentice is started at a wage of $5 a week, which is increased $1 at the end of each six months during a period of four years. In addition to this, his employer deposits in a fund $1 each week during the entire period, making a bonus of $208 with accrued interest. It is understood that this $1-a-week bonus is not in any sense part of the boy's wages, but is offered as an inducement for him to serve his term faithfully. The agreement is made with the boy's parents and provision is made that the amount deposited will be forfeited upon failure of the apprentice to observe the agreement.

Using the American Machinist

It is one thing to have valuable information in books or periodicals, and too often quite a different matter to find it without loss of time when you need it.

The Brown & Sharpe Manufacturing Company has a very complete system of indexing and keeping track of the AMERICAN MACHINIST and such other periodicals as are of interest in its line of work. This method has been developed by Mr. Burlingame.

In addition to the regular indexes which are filed each year in a binder until enough accumulate to be bound into a regular volume, there are scrap-books for collecting together articles on the same subject, so as to be readily found.

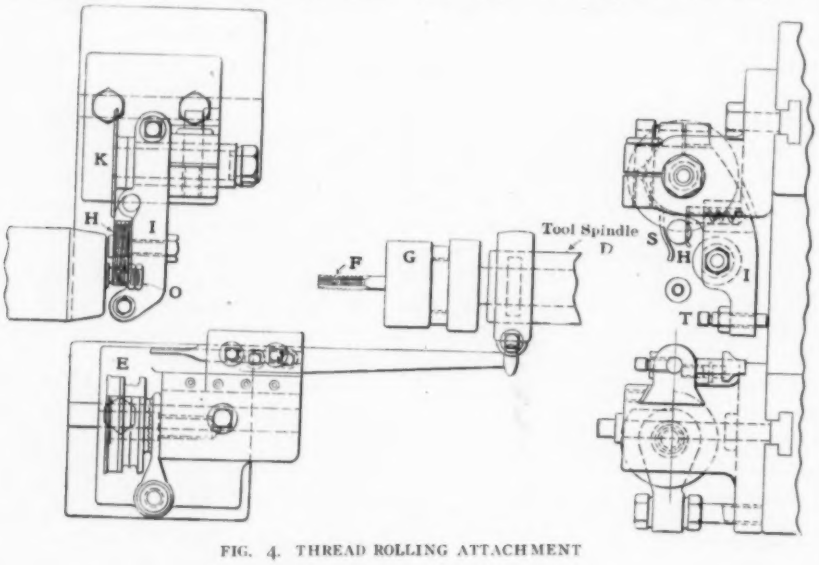


FIG. 4. THREAD ROLLING ATTACHMENT

They secure an extra copy of the index, which we would be glad to supply to anyone for a similar purpose, and clip it for filing under separate heads, as shown below:

MILLING MACHINES AND THEIR WORK.

1901.

Milling a bracket casting. Fixtures for William Doran. *1294
a radial groove. A. B. Christman. *1010
a spindle. Fixture for. A. B. Christman. *632
and boring machine for small-lathe beds. A special. Automatic Machine Co.'s *681
Calculating angles for spiral. H. C. Peters. *462

1902.

Milling and drilling job. A. N. A. C. *801
attachment for lathe. Frasse. *453
machine. A cam-cutting attachment for the Brown & Sharpe Mfg. Co.'s *977
machine and special cutter grinder. Thread. Pratt & Whitney Co.'s *1629
machine, fractional indexing. C. E. De Puy *1506

SCREW MACHINES.

1905. Part 1.

Screw machine. Automatic Machine Co.'s friction pulleys, cross slides, turret slide, etc. *744
Screw machine. Turning tool for. Toomey. *738
Screw shaver step chucks and closers. Pratt & Whitney Co.'s *358

1905. Part 2.

Screw milling-machine fixture for cutting screws. Chattanooga Machine Co.'s *280
Screw-cutting lathe for National Physical Laboratory. Precision. *619
Screw machine tool for recessing turn buckles. L. F. B. *330

Taking as an example the subject of milling machines, their plan is to clip from the yearly index all that interested them on the subject and paste it into the scrap-book under the year in which it appeared. The next year's index on the same subject is pasted directly underneath, the years 1901 and 1902 being shown. Room is left for ten years' indexes on each subject, as nearly as can be estimated; and the fact that they have been using this system for some time enables them to form a fair idea of the necessary space.

The various subjects are treated in the same manner; as a result, for any subject they are likely to need they have the best quick-reference index that we know of.

We believe this plan can be followed to advantage by nearly all the builders of machine tools and appliances, as it gives them a quick reference to all that has been published in their line and gathers it into a compact space so that it can be found at once.

Abbreviating Courtesy.—"Marcus Aurelius," remarks the New York *Tribune*, "held that no man should ever be so busy as to have no leisure. Yet here is the telephone company in Philadelphia requesting that in order to save time subscribers will not say 'please' to operators in calling for numbers and decreeing that operators shall never use that unnecessary word. There are some places in which such sacrifice of courtesy to curtness would not be surprising. But we did not expect it in the City of Dignified Deliberation."

An Osaka paper states that aside from two torpedo crafts recently ordered by Governor Chang-chi-tung in Japan, and already delivered at Wuchang, an order for twelve other war ships of different types has now been let in Japan by China.

The Troubles of the Tool Designer

BY H. J. BAKER

The position of the jig and tool designer is far from enviable in many ways. If he makes his jigs at all elaborate, the management kicks; if too simple, the shop assumes the offensive. If he consults with the man who is to use the jig, the natural query from headquarters is "What do we pay *him* for?" If, however, he does not consult the user, he generally discovers that the foreman of the department has a conscientious objection to U washers and would prefer some other means of clamping the work. Should the alteration be made, there is a direct charge of incapacity hanging over the unfortunate head. If it is *not* made, however, that jig is doomed, and from it no good work is likely to come until the foreman is changed.,

The general feeling of the machine designers toward the tool man is not happy. Should he suggest that a certain change be made to facilitate machinery, he will probably be told that the designers are not there to make pieces for him to machine, but that he is there to machine the pieces they design. So after seven hundred (or thereabouts) rebuffs of that kind, he gives it up as a bad job and placidly designs tools for any absurdity they may send down to him.

The commercial end of the business also fail to see much that is good in the tool draftsman. To them, in the majority of cases, he appears an overpaid ornament. Their idea is that the foreman should, in addition to his other duties, design the requisite jigs and fixtures for their departments. In any case they should suggest them and have the junior draftsman prepare the actual drawings. It is not clear to them that the efficiency of the shop is at all likely to be impaired by this method of procedure.

The shop man himself frequently regards the tool draftsman with considerable suspicion as one through whose malign influence he will be compelled to work longer hours for less money. Therefore he shuts up as close as a coal trust when any information is required. Then again, the comparative sameness of the work is not calculated to impress the heads of the concern with a very great regard for the powers of the designer—one jig looks a good deal like another—and to that must be added the effect which reading the "Situation Wanted" columns will produce. To see there a long array of draftsmen and designers, foremen and superintendents, office boys and stenographers, all—after a lengthy recital of their more important qualifications—claiming a thorough understanding of the ways of jigs and tools is a humorous sight.

It does not, however, particularly strengthen the tool draftsman's position.

And yet one is tempted to hope that the sad state of things depicted above is rapidly passing away. Certain it is that the age of specialization calls for more and more effort on the part of the jig and tool man. Certain it is that when two modern firms are making a similar article the supremacy of the one will largely depend upon the capabilities of the tool-designing department.

It is becoming more and more the practice of firms—not necessarily large ones, but with wide views—to give over to specialists in tools and labor-saving devices the complete control of these manufacturing methods. In one big English machine-tool shop employing some 1800 men there are two special tool-designing departments, one of which attends to the firm's own requirements while the other works altogether in outside work for customers.

In the two departments there are some 24 designers besides juniors and tracers. In a number of the better shops on this side of the water the tool man is identified with the newly designed work, from the preliminary "lay-outs" until the job is on a manufacturing basis.

The introduction of the Taylor system of management calls for the competent tool man. In this case he is absolutely indispensable. In fact, one might enumerate *ad infinitum* the causes that will in the near future make the lot of the tool designer less thankless than heretofore.

Specialization, the greater use of unskilled labor in machine shops, the decrease in the number of all-round mechanics, the general tendency to localize methods of production in one center, all pave the way to a greater sphere of usefulness for the tool man. It may be confidently expected that the time when he will feel his trade to be the most thankless in the engineering profession will soon be a thing of the past.

Reciprocating Attachment for Engine Lathes

By E. Beck

In our shop we had many different pieces to make which were to be finished at different arcs, such as cams, die and punch work, etc.; these two or more different radii to be finished would extend for a part of the circle only, necessitating using the milling machine, milling as close to the lay-off lines as possible, or when the work was bored to receive an arbor, the arbor and work were placed in the lathe centers and the old-fashioned mule power was resorted to. The mule power consisted of a lever clamped to the work or arbor, the work being moved back and forth with the one hand while the other hand handled the lathe carriage-feed arrangement; the file is always a "last aid" when done this way. The reciprocating attachment for engine lathes, as per the drawings furnished, seems to be "just what the doctor ordered."

Fig. 1 is a front elevation, part of the lathe bed and headstock being shown in faint lines. *A* is the reciprocating face plate and is fitted internally with a collapsing bronze taper bushing sawed in three parts from each end alternately two-thirds of its length. This bronze bushing is forced in the face plate, when wishing to take up wear, by means of three fillister-head screws. The movement of the face plate and bronze bushing is upon a mild-steel, pack-hardened and ground sleeve *B* screwed upon the lathe spindle. The steel sleeve, as well as the hub of the face plate, is provided with a flange where they come together. This is to provide for clamping bolts to be tightened only when the lathe is used other than reciprocating.

The clamping-bolt heads (see Fig. 2) are made so as to allow the face plate to move readily forward or back. An opening is provided in the face-plate hub (not shown) for the admission of clamping bolts. The spindle sleeve *B* is bored to receive the regular lathe center. A steel collar *C* is screwed upon the end of the spindle sleeve *B*, the face plate being recessed for it. This retains the face plate in place.

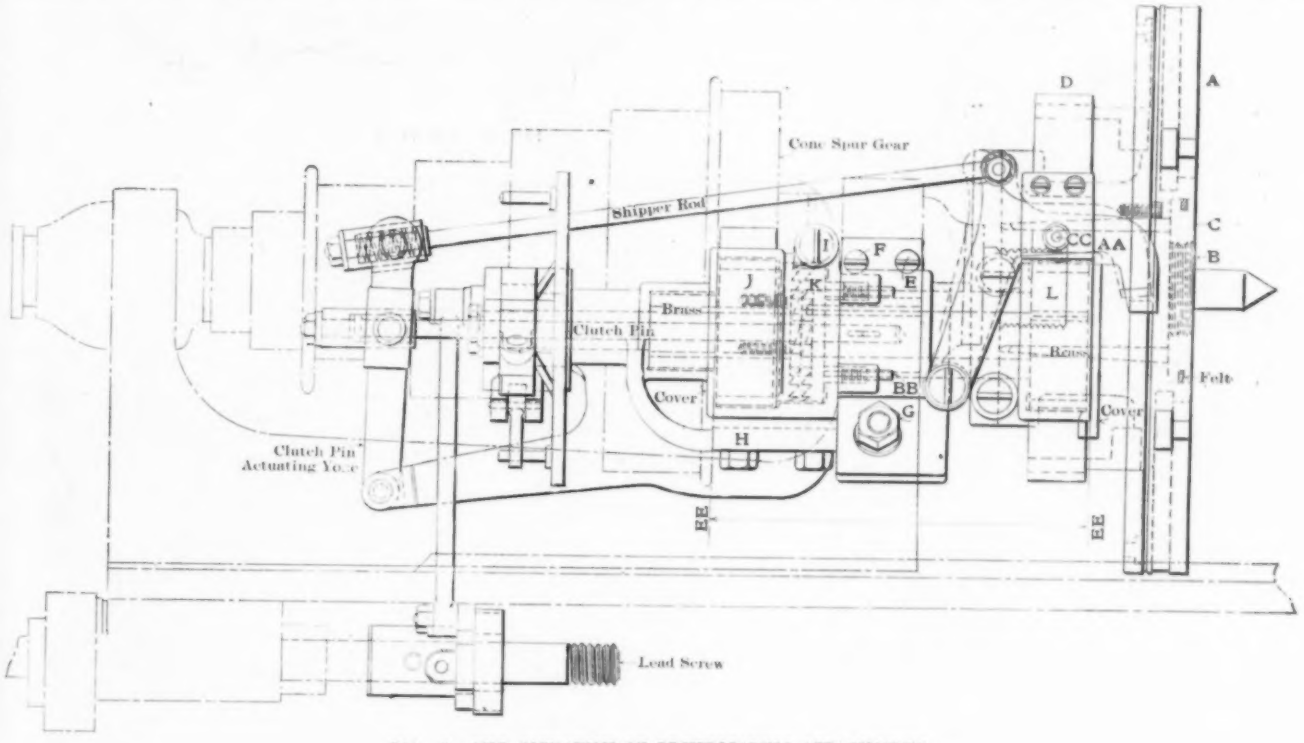


FIG. 1. SIDE ELEVATION OF RECIPROCATING ATTACHMENT

It will be noticed that the collar *C* is packed at its periphery with felt; this keeps all dust from getting in the bearings. *D* is the face-plate gear and is bolted to the back of the face plate with fillister-head screws, as shown at Fig. 5. *E* is the cap of the body casting. The length of the body casting and cap is from *E E* to *E E*, each end being covered to prevent admission of dust or dirt. The body casting is provided with a flange at the side and also at the end of the headstock, and is fastened to the headstock, on the side, by two fillister-head screws *F*; also by the stud and nut *G*. The body

casting is also fastened at the end of the headstock by fillister-head screws, as shown in Fig. 2. A one-piece telescope-shaft bracket *H* bolts to the under side of the body casting and cap, and is made to overlap the body casting and cap (see Fig. 5). The cap is tongued to the body casting and is also held by the fillister screws *I*. It will be noticed that an arm extends from this one-piece casting *H* forming the lower connections of the clutch, actuating the pin yoke. The steel pinion *J*, driven by the cone spur gear, is brass bushed and runs continuously on the telescope shaft in the one direction when the lathe is in motion. A pack-hardened saw-tooth clutch is fitted to the face of this pinion and is held by screws and doweled, the clutch having an angle of 5 degrees at tooth contact, to facilitate release at the end of the stroke. I will use a few planer terms now, as the action of the face plate is very similar to the movement of a planer table, only that the one moves through an arc while the other moves in a plane.

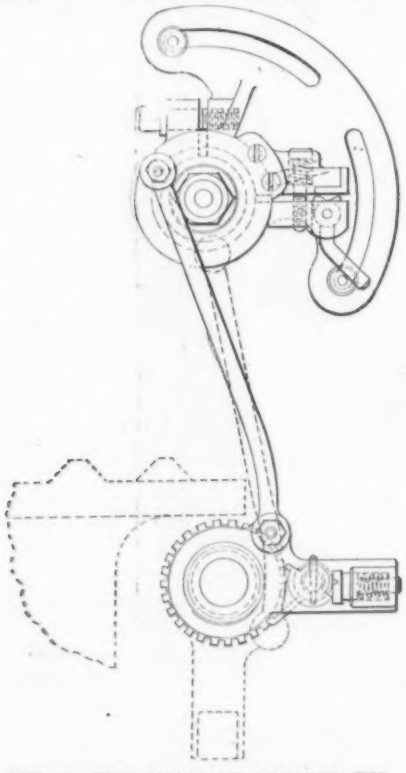


FIG. 3. FEED QUADRANT, RATCHET, ETC.

In starting the lathe, the release dog comes in contact with the lug *A* on the shipper lever, Fig. 5. This disengages the clutch *K*, the weight (described later) at the back of the lathe causing the face plate immediately to start on its return until the go-ahead dog comes in contact at *B*, when the clutches are again in contact and the face plate moves forward. The face-plate dogs are of course to be set wherever wanted. A T-slot being provided entirely around the back of the face plate for the dog-bolt heads, an opening is made in the front of the face plate for the admission of the dog bolts. *A A* is the shipping lever and is fulcrumed from the lower side of the body casting cap. Connecting with the upper part of *A A* is the shipping rod, which in turn connects with the clutch *K* actuating the pin yoke. It will be noticed that the yoke end of the shipper rod is made to telescope, its swivel bearing collapsing a spring. This is so that should the clutches meet at or near the point of tooth, no harm can arise. The pull on the actuating pin yoke is positive when disengaging the clutches at the end of the stroke. Four spring-actuated plungers act against the back of the clutch *K* to insure the clutches being well together before any working strain comes upon them; the retaining of the shipper lever *A A* at each end of the stroke is by a spring-actuated plunger *C C*.

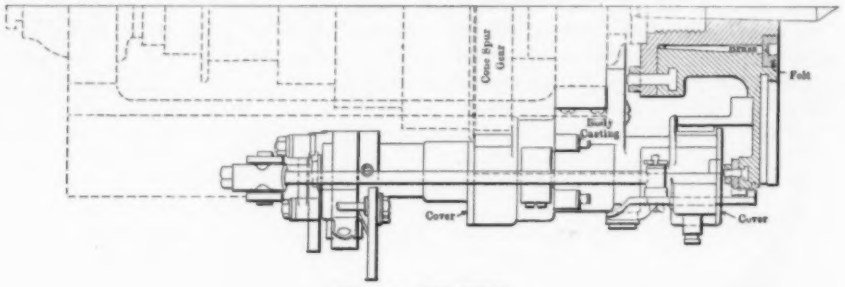


FIG. 2. TOP VIEW

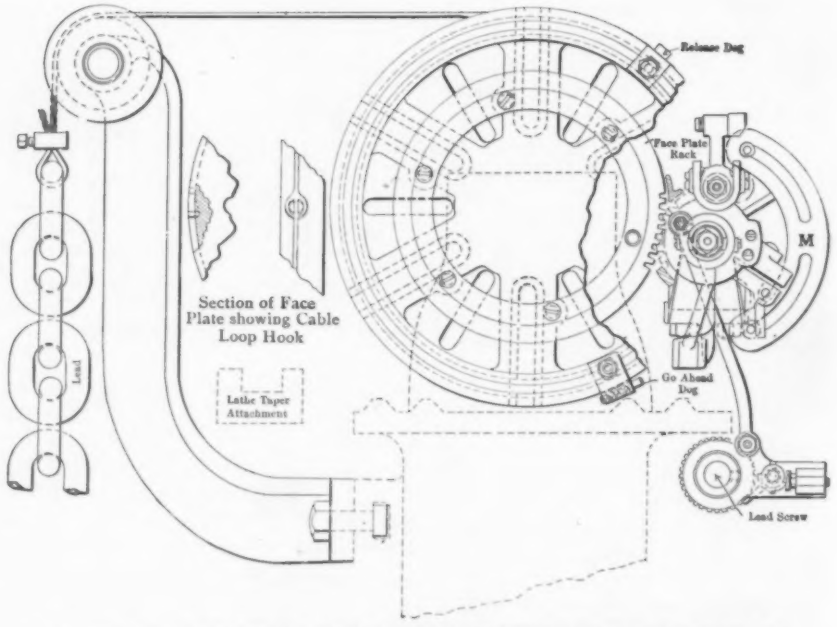


FIG. 4. END ELEVATION TOWARD FOOTSTOCK SHOWING GEAR AND PINION, GO AHEAD AND RELEASE DOGS

The sliding clutch *K* moves endwise upon the telescope shaft, the clutch and shaft being splined and keyed. The outer diameter of the clutch hub has a bearing in the body casting and cap. A flat pin of ample size to actuate the sliding clutch *K* passes through the clutch hub, in which it is a snug fit, through a slot in the telescope shaft (a loose fit) and also through the clutch-actuating pin. The clutch pin at its outer end runs in a brass swivel bearing so made as to overcome the over-the-center movement of the clutch-actuating pin yoke. This connects the train of end moving parts. The pinion *L*, driving the face-plate gear *D*, is keyed to the solid end of the telescope shaft and is a duplicate of the running idler pinion *J* in so far as diameter and pitch of teeth are concerned. So also is the lathe cone spur gear and face-plate gear *D*, making the forward movement of the face plate exactly the same as that of the lathe spindle, regardless as to whether the lathe is run single or back geared.

The feed mechanism can best be seen at Fig. 4. A bronze disk of ample width is keyed to the end of the reciprocating telescope shaft. Enveloping this disk is a cast-iron ring with extending lugs. A bolt compressing a spring gives the necessary friction for actuating the feed ratchet. A cam arrangement opens the ring at each end of the stroke, releasing the bronze disk and relieving the ring of excessive wear. Pins are provided in the quadrant *M* for adjustment of the feed, the pins in the drawing showing the maximum feed of 32 per inch, the minimum being one tooth of ratchet wheel, or 224 per inch. The feed ratchet is shown as mounted upon the lathe lead screw. The lead screw has eight threads per inch.

Fig. 4 shows the back of the face plate,

both the go-ahead and return dogs, the return cable, the roller arm, the roller weight, etc. A portion of the outer part of the face plate, together with the cable loop hooks, is shown. Six of these hooks are provided, so that the hook best suiting the work conditions is used. I have adopted a lead chain as best meeting the weight requirements, the entire weight of the chain causing the face plate to start rapidly backward after release, decreasing, however, as the weight of the chain becomes less as soon as the end touches the floor, allowing the go-ahead dog to move the shipper lever without any violent jar. The substitution of lead for iron was to avoid that clanging noise peculiar to iron chains. Fig. 2 is a top view, with the moving parts incased in the body casting. A section of the face plate, rack spindle sleeve, taper bronze bushing, retaining collar, etc., is shown.

Fig. 3 is a plan of the feed, showing in dotted lines feed limits.

Fig. 5 is an end elevation looking from the footstock.

The mounting of this reciprocating attachment was upon a Pratt & Whitney taper attachment toolmakers' lathe; the attachment can, however, be as readily put upon any other make of lathe, changing such parts as the nature of the case demands.

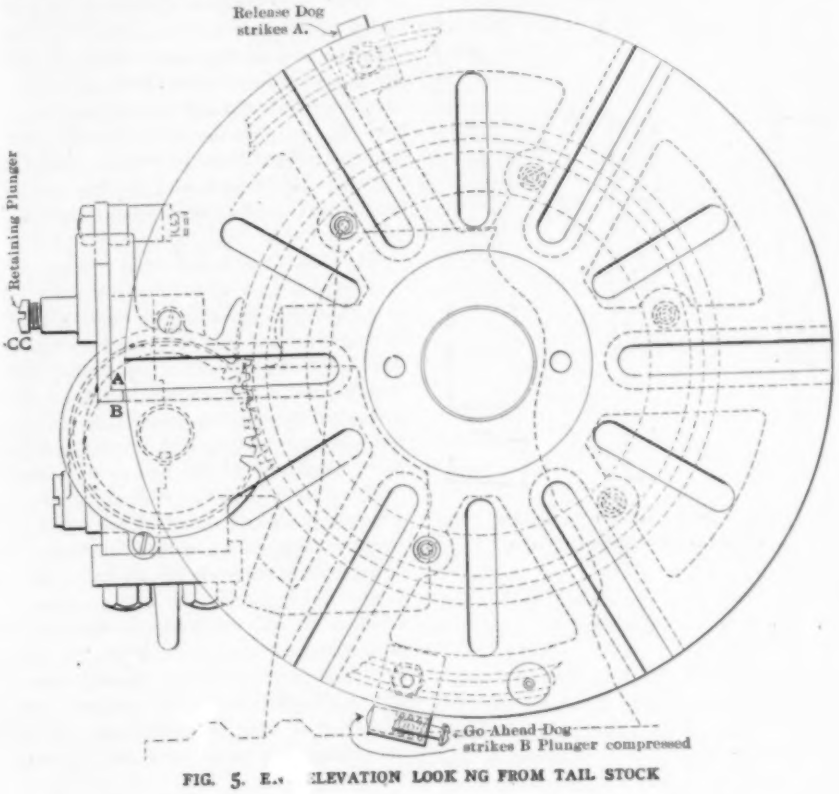


FIG. 5. E.. ELEVATION LOOK NG FROM TAIL STOCK

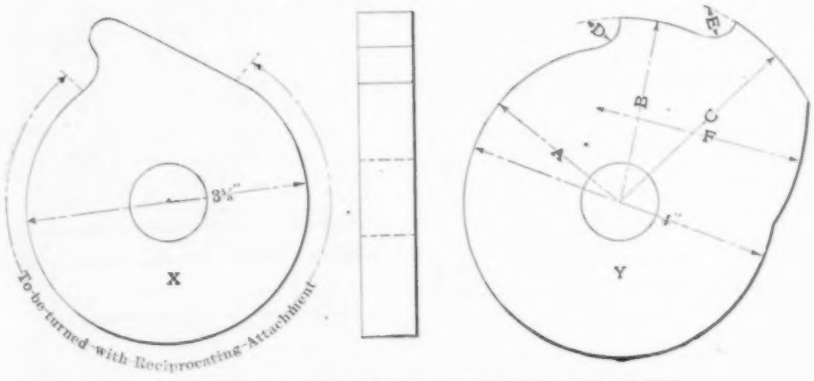


FIG. 6. SAMPLES OF WORK DONE WITH THE ATTACHMENT

Some slight changes have been made since printing these blue prints; for instance, a different clutch is used, having a somewhat shorter tooth; also the shipping lever is now made so as to throw over out of the way of the dogs, allowing a continuous forward movement when turning all round work; simply throwing the shipping lever back between the dogs makes the lathe reciprocating.

I send you drawing of work samples that are advantageously and quickly done with this device. Fig. 6 shows samples of work turned with the reciprocating attachment. In the piece *Y* the entire turning was done with the attachment. An arbor was used for turning arcs of which *A B C* are radii. *D, E* and *F* were done on the face plate.

Unfortunate Business Methods

Consul-general G. E. Anderson, of Rio de Janeiro, writes:

A traveling representative of a great American agricultural-implement concern reports to me that as a result of the methods followed by his principals he has just lost the business of a firm aggregating $80,000 last year, with prospects of an immense increase the present year, and that present indications are that he will lose the business of another South American house aggregating $200,000 annually with his people for the same reasons. The chief occasion for this discouraging outlook is the failure of the firm in question to ship goods within the time limit agreed upon, and in a number of cases the time actually required for the filling of an order has been extended from the five months agreed upon and accepted by the house to over a year. This same firm received an order for 500 hand-guiding plows. It shipped that number of automatic-guiding plows. The difference is that in Brazil an automatic-guiding plow is practically useless, while a hand-guiding plow can be used.

Another case of not filling orders according to instructions given is afforded by the experience of a local firm which has had considerable dealing with the Government here. Recently the Government wished to buy a number of automobiles for a special purpose and had the Rio de Janeiro firm write to its New York agency and secure quotations. The quotations were given and the Rio firm ordered six machines of a certain grade and of 25 horse-power each. The American firm shipped six machines of 30 horse-power each, writing that it did not have the machines of the lower power and billing the machines at the increased price of the higher powered machines. The point to this transaction was that the Rio de Janeiro firm, having in effect made a tender or bid to the Government for machines of a certain grade at a certain price, had to furnish the higher-priced machines at the lower price and stand the loss. The actual tangible loss of firms in such position naturally is considerable. Perhaps the more lasting effect is due to the annoyance and irritation produced by such business methods. These methods are not at all characteristic of American manufacturers generally in the export trade, but they are common enough to have a very marked effect upon American trade.

Manganese is the best deoxidizing agent for nickel and its alloys and is now extensively used. Not only does it remove the oxygen, but the sulphur as well.

A Boring, Reaming and Facing Bar—How It Was Made

By E. John.

There has been considerable written of late on the subject of boring bars. While the subject is fresh in our minds it may not be out of place to describe how a large bar was made.

The bar in question was a large special one; as the use to which it was put was not likely to be of a steady nature, expense was a matter of considerable account. The quality of the work desired was also to be considered; and as this was to be of the highest standard, ordinary designs of bar would not answer. What was needed then was a bar that would do the highest quality of work for the least outlay.

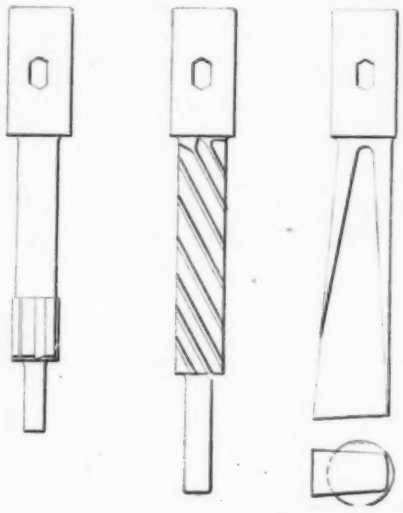
The work was a dozen large castings having four large holes and two axes, which were to line accurately; each hole was to line with its mate. Two of these holes (on one axis) were taper, with the taper of one running in the opposite direction to that of the other.

After due consideration it was decided that the boring cutter should be made of flat steel. Results have shown that this decision was warranted.

When it came to the matter of reamers it was decided to use flat reamers, as that style would permit the use of the bar for both boring and reaming. The size of the bar was determined by the diameter of the smaller taper hole, as the straight holes were much larger. The bar was then made 3 inches diameter. It was also decided to use the bar as a facing bar.

The boring cutter, shown in Fig. 6 at *A*, for the straight holes, which were 6 inches in diameter, were made of high-speed steel about 2 inches wide and ½ inch thick. These cutters were made to bore the hole about 1/32 inch undersize, leaving that amount of stock to be cleaned out by the reamer shown at *B*, Fig. 6.

The reamer, which was also of ½-inch flat stock, was an inch longer than the cutter. As the casting had a slot sawed through at each side, it was deemed best to make a spiral cutting edge on the reamer to insure a smooth hole and prevent the tool from striking the slot a blow at each revolution and spoiling the finish of the hole. As this slot was about 3/16 inch wide, the blade was made with a helical edge having a lead or pitch of ⅜ inch in the length of the blade. This reamer left a very fine finish in the hole and a hole that was perfect in other important respects.



FIGS. 3, 4 AND 5. THE COUNTERBORE, THE MILL AND THE SLOTTING TOOL

The cutters for finishing the taper holes, shown at *C* and *D*, Fig. 7, are of interest. The roughing cutter was a stepped affair. In stepping this cutter it was not turned taper first and nicked afterward, but was turned so as to have a number of steps all parallel with the axis of the bar. These steps were then backed off and relieved back of the cutting edge. These cutters then cut with an action similar to that of the boring cutter, producing a hole with a number of concentric rings without the least perceptible chatter and with very little power or strain on the bar. Compared with the action of the ordinary taper reamer with its screeching, chattering cut, it was a perfect success and the experience opened the eyes of those interested. The hole thus roughed out, the finishing cutter or reamer *D* was used, producing a high grade of finish and accuracy.

The facing cutters, Fig. 8, were also made of flat stock long enough to cover the largest boss. The only precaution in connection with these cutters was to make sure that the cutting face was square with the axis of the bar.

After the question of cutters was decided and it was seen that one bar could be utilized to do the work of two or more, as would ordinarily be the case, the construction and method of holding the cutters was a question that troubled some. It was decided that the best for the present case would be to slot the bar and hold the cutters in place with wedges and taper pins.

The bar was first turned and ground, and fitted with a large Morse shank which was the size of that in the spindle of the boring, milling and drilling machine on which the boring was to be done. Since the feeding of the cutters had to be done in both directions on account of the taper holes facing as they did, a cotter pin had to be used to hold the bar in the spindle.

Fig. 1 shows the bar set up with boring cutter, taper reamer and facing tool. The cutter is first placed in the slot and seated in place by means of the wedge, which is driven firmly home. In order to prevent accident should the wedge loosen up, the taper pin was used to hold the cutter firmly in place, and was reamed into the hole while the cutter and wedge were in position. It will be noticed that the boring cutter and facing tool are backed up with blocking, which is necessary owing to the difference in length of the three different blades.

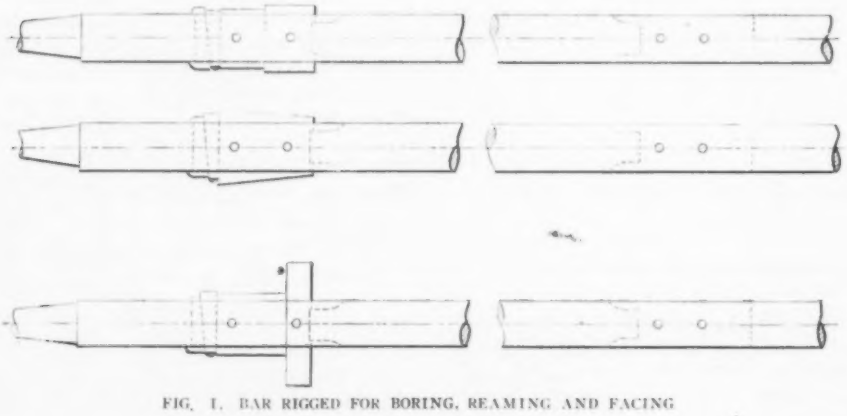


FIG. 1. BAR RIGGED FOR BORING, REAMING AND FACING

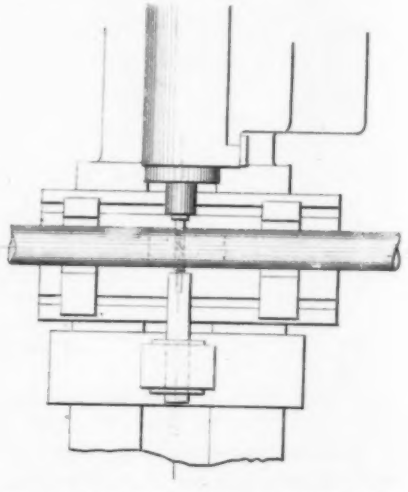


FIG. 2. PLAN OF MILLING MACHINE WITH BAR IN PLACE

The job of getting the slots in the bar was a problem that puzzled us for some time. Just how to go about the job in order to get them as near central with the bar as possible without too much work was what caused the most trouble. Had it been possible to obtain a machine that was

in perfect alinement, the job could have been done on centers working out the slot from both sides. But on ordinary machine tools, even had it been possible to find a machine that would handle a job as long as this bar, the alinement is none too good, especially after a few years of use.

On our tool-room floor is a boring, drilling and milling machine that is used for boring jigs. It was decided that the job could be handled on that machine in a manner that would give what was wanted in the way of results and be about as cheap a way as any.

Two V-blocks were clamped to the table, and the bar was fastened on the blocks at right angles with the spindle, as shown in Fig. 2. The squareness of the bar with the spindle was tested with a swinging trammel inserted in the taper hole in the spindle.

A small drill was then placed in a suitable chuck in the spindle and a series of small holes was drilled through the center of the bar from side to side the full length the slot was to be. This drilling was carefully done and the drill accurately ground so that the hole would be straight and true to size. The drill was fed through by hand and not forced, as any such tactics would be apt to cause trouble, so that *"less haste more speed"* was our motto throughout the job.

After the holes for one slot were drilled, it is obvious that but one slot could be done at a time—a counterbore similar to Fig. 3 was substituted for the drill and the holes enlarged. Since the holes were drilled very close together, it is plain that the counter would remove the major portion of the material, leaving only a slight amount to be removed afterward. The fit of the counterbore fitted the hole so that it was guided and could not run off. The diameter of the counterbore was slightly under the finished size of the slot.

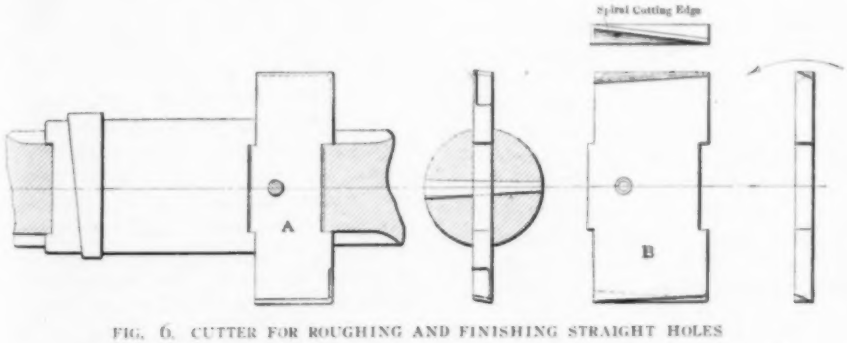


FIG. 6. CUTTER FOR ROUGHING AND FINISHING STRAIGHT HOLES

Having thus removed the great bulk of the stock, the process of finishing the slot up to the required thickness was carried on. Two milling cutters like Fig. 4 were made, one being of such a diameter that it would mill the slot out to the required width at one pass, and the other slightly under the finish size to straighten out the slot, for the slot as the counterbore left it was merely a series of enlarged holes in the bar. The milling cutter was supported on the outer end by the tail stand, and the table was fed by hand. In this manner the sides of the slot were finished; but the ends were left rounding, whereas to afford a good seat for both cutter blades and wedges, it was necessary that they be square and at right angles to the axis of the bar.

To square up the ends, a slotting tool like Fig. 5 was made and placed in the chuck; by means of the movement of the spindle parallel with its axis the round ends were worked out to the desired shape.

By this means the slot itself was finished. The extension of the slot at the end to form the centering seat for the cutter was next to be milled. This was accomplished with a plain milling cutter on an arbor in the boring-machine spindle and supported by the bushing in the tail stand. The bar was rotated in the V's so that the slot stood in the vertical position, the cutter being set to the slot and the extension milled.

The time spent on the job of slotting was three days, which included the making of the tools described—not very bad time.

The cutters were then planed to thickness, or rather planed and then ground on the surface grinder, to fit the slot. The recess was also made in the end, and the

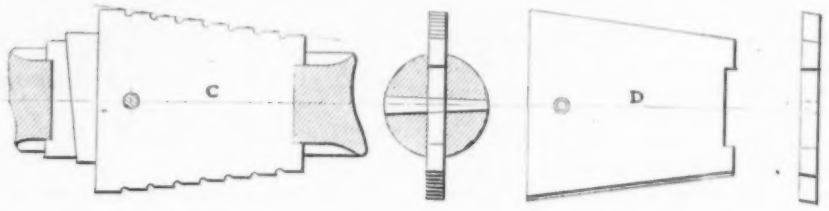


FIG. 7. ROUGHING AND FINISHING CUTTERS FOR TAPER HOLES

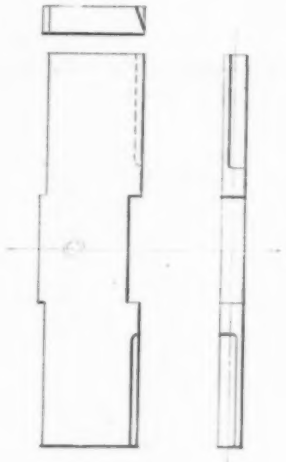


FIG. 8. THE FACING CUTTER

wedges were in each case fitted. When this was done, the taper pin was fitted for each cutter.

The cutters and blocks were marked to identify the position they were to have, as no attempt was made at interchangeability with regard to the slots or cutters.

The cutters and reamers had to be turned while in place in the bar; as we had no lathe available for such a long piece of work, two lathes had to be rigged up in the usual way to take care of the job. The makeshift is that familiar one of turning the tailstock around on one lathe and lining it up with the head center of the other lathe. In this manner the cutters and reamers were all turned true and sufficiently over size to allow for grinding after being hardened. In turning the taper reamers a power-feed rig was made for actuating the compound rest. This rig consisted of the speed lathe, which was set at the angle of the taper with the center of the bar. A wooden roll was placed on the centers and dogged to the live spindle, from which power was transmitted to the compound-rest screw by means of a belt, a flanged pulley having been substituted for the ball handle on the screw.

After all the cutters were thus turned they were backed off by milling the edges back at an angle and leaving a land of about 3/32 inch wide for a cutting edge which was to be ground after hardening.

The original bar, in which it has been explained that all the cutters were turned, was too long to place in the milling machine or the grinder, so that some other means had to be used to hold the cutters during the milling and grinding operations.

A short piece of stock that would finish to the size of the bar was obtained and turned. This piece was then slotted off from one side and below the center equal to one-half the thickness of the slot.

so that when the cutters were clamped to this surface they would be central with the axis, as would be the case when in place in the boring bar. The cutters were clamped to this short bar and centered with the indicator so that the turned edges would revolve true with the axis. By this means it was possible both to mill the edge and grind the cutters, so that when placed in the slotted bar they would run true with its axis. It will be obvious that much depended on this small bar, and great pains was taken to have it true and accurate in all respects.

Some apprehension was felt as to the success of the hardening, but everything came through without the least difficulty, due to the skilful handling of those connected with the work.

The results obtained by the use of the bar were of a degree of accuracy that was well above anyone's expectations, and the experience gained will be of everlasting benefit to all. It is hoped that those who read this may benefit as we have from the obstacles overcome in the course of the work.

Size of Stock for Bolts Having Rolled Threads

By F. Webster

In the thread-rolling process the metal is forced outward by the pressure of the dies and forms the point of the thread. It is not a cutting process, but is a cold-forging process. The outside diameter D of the finished thread is larger than the diameter d_1 of the stock from which it is rolled, as shown in Fig. 1. It is necessary, therefore, to select stock that will make the thread of the required diameter in each case. The derivation of the formula to use for this purpose is given below. This formula, however, is based on theoretical considerations, and it is necessary to allow for the distortion of the metal and to make corrections in each case as determined by experiment.

In Fig. 1 is shown a United States standard thread that has been rolled on the rod, with the finished diameter D of the thread and the required diameter d_1 of the rod to make it. The thread is shown in Fig. 2, drawn to a larger scale, with the different measurements in terms of the pitch indicated. The width of the point and root is $\frac{1}{8}\ p$, and the hight is $0.65\ p$. The hight of each of the equal areas A and B equals $0.325\ p$. The pitch line is drawn through the middle of the hight of the thread, making the area of A at the root equal the area of B at the point. The pitch diameter is shown at d, and the diameter of the stock necessary to select in order to make the thread of diameter D is shown at d_1. The area of $A = \left(\frac{\frac{1}{2}p + \frac{1}{8}p}{2}\right) 0.325\ p = 0.1015\ p^2$, and, as stated above, B has the same area.

The volume of A, that is, the amount of metal in one turn of the ring, is equal to the area of A multiplied by the length of the circle passing through the center of gravity of A. The distance of the center of gravity of A measured from the outer edge toward the axis of the bolt is $0.13\ p$, which is found by applying the regular rule for getting the center of gravity of any trapezoid. The radius of the center of gravity of $A = \left(\frac{d}{2} - 0.13\ p\right)$, and the volume of one turn of the ring having an area of $A = \left(\frac{d}{2} - 0.13\ p\right) 2\ \pi \times 0.1015\ p^2$. The radius of the center of gravity of $B = \left(\frac{d}{2} + 0.13\ p\right)$, and the volume of ring $B = \left(\frac{d}{2} + 0.13\ p\right) 2\ \pi \times 0.1015\ p^2$.

As B was assumed of the same area as A, and as its center of gravity radius

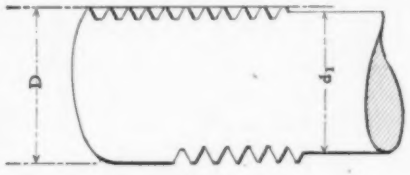


FIG. 1

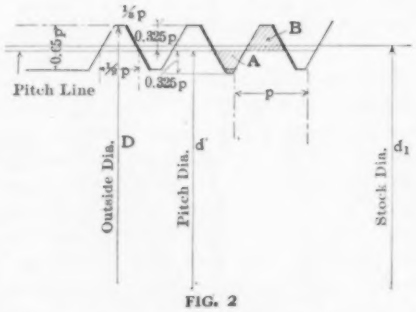


FIG. 2

DIAGRAM FOR COMPUTING SIZE OF STOCK FOR BOLTS WITH ROLLED THREADS

is longer than that of A, the volume of its ring must be greater. In other words, the material forced from A in the rolling process will not fill the volume required by B. Hence, some diameter d_1 larger than d must be used for the stock. To find this diameter d_1, proceed as follows: $(B - A) = 0.26\ p \times 2\ \pi \times 0.1015\ p^2 =$ the deficit of stock to be furnished by the new volume of A. The volume of stock for a length p of the screw, and with a pitch diameter d equals $\frac{\pi\ d^2}{4} \times P$. To this add the volume of $B - A$, to get the total volume required for the work, and then compute its diameter d_1. Thus, $\frac{p\ \pi\ d^2}{4} + 0.26\ p \times 2\ \pi \times 0.1015\ p_2 =$ the volume of stock having a diameter d_1. The area of this volume equals $\frac{\pi\ d^2}{4} + 0.26 \times 2\ \pi \times 0.1015\ p^2$, from which $d_1 = \sqrt{0.21124\ p^2 + d^2}$. The pitch diameter d of the thread equals the outside diameter $D - 0.65\ p$. The more exact measurement, however, is $D - 0.645\ p$. Substituting this value in the value of d_1, gives:

$$d_1 = \sqrt{D^2 - 1.3\ D\ p + 0.63\ p^2}$$

The use of the formula will be shown by calculating the size of stock for a thread of 1/13-inch pitch and ½-inch diameter.

Solution:

$$d_1 = \sqrt{0.25 - (1.3 \times 0.5 \times \tfrac{1}{13}) + \tfrac{0.63}{13^2}}$$

$$= \sqrt{0.1963} = 0.44 \text{ inch.}$$

The difference in diameter is, therefore, 0.06 inch. The hight of a United States standard thread of 1/13-inch pitch is approximately 0.05 inch, so that the short rule that is sometimes used is to select stock having a diameter equal to that of the finished thread less the hight of the thread. If closer work than that given by the rule is required, use the formula and compute the diameter to three or four decimal places. The dimensions of threads can be found in handbooks or catalogs.

A New Solder for Aluminum

Letters patent covering a new solder have been issued to Carleton Ellis, of Boston, Mass., under date of August 13, 1907.

It is claimed that this solder is strong and durable, has a low fusing point and unites easily with the aluminum. It consists of an alloy of tin, zinc, aluminum and manganese, tin being the constituent used in greatest relative amount; the manganese is added only in relatively small quantity. The latter ingredient is used to improve the texture of the alloy and to increase the durability of the soldered joint. Chromium may be added if desired. Suitable proportions for a satisfactory solder are tin, 30 parts; zinc, 7 parts; aluminum, ¾ part; manganese, 1/10 part, or using chromium with manganese, tin, 30 parts; zinc, 8 parts; aluminum, 1 part; manganese q. s.; chromium, 1/16 part. The solder may be prepared by fusing together the above described elements. If desired the manganese or chromium may be added in the form of their respective aluminum alloys. To secure the best results the fusion should be made in a closed crucible, as free access of air to the fused alloy appears to injure the working qualities of the resulting solder.

Automobilists in England are not pleased by the present price of "petrol," 30 cents a gallon in London, and up to 36 cents in the country. A competitive fuel is evidently needed there.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Calculations Respecting Epicyclic Wheel Trains

Considerable attention has of late been given in your columns to the calculations of epicyclic wheel trains. Many of your readers will remember the articles by F. J Bostock and W. Owen on this interesting subject. Now the former of these writers admits his scheme of solution to be somewhat complicated. He has to work his last example by five stages. The methods, or rather formulas, given by W. Owen certainly admit of a simple solution of epicyclic wheel problems. Doubtless many of your readers will be interested in the following method of solution, by Professor Dunkerley; by it a simple epicyclic wheel train, or a complex compound epicyclic wheel train, presents little or no difficulties, if the simple application here given is followed out. Referring to Figs. 1 and 2, let the wheel *A* have 40 teeth and let the wheel *B* have 20 teeth. Fig. 1 represents an ordinary train. The arm *XY* is fixed. Let wheel *A* make one revolution in a clockwise direction; then the wheel *B* will make two revolutions in a counter-clockwise direction relative to the arm which is fixed.

Fig. 2 is an epicyclic wheel train. The wheel *A* is fixed; the arm *XY* is free to rotate and makes one revolution in say a counter-clockwise direction. Then the wheel *B* will make two revolutions in a counter-clockwise direction relative to the arm. But the arm has made one revolution; therefore the wheel *B* has made two revolutions relative to the arm plus one revolution to the fixed wheel *A*. Thus when the motion of one wheel is required relative to the second, we may first consider the motion relative to the arm, then move the first wheel back (that is, to rest) by impressing upon everything the same motion. The relative motion will still remain the same in both Fig. 1 and Fig. 2. We must be careful to note that if wheels rotate in opposite directions the rotations must be of opposite signs. The foregoing will be clearly understood in the tabulated form, thus:

	Wheel *A*. Revolution.	Wheel *B*. Revolutions.	Arm. Revolution.
Arm fixed	1	− 2	0
Wheel *A* fixed ..	0	− 3	− 1

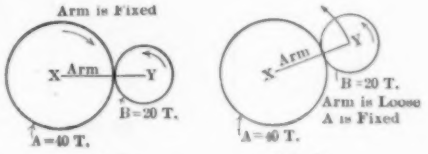


FIG. 1 FIG. 2

TWO PROBLEMS IN EPICYCLIC GEARING

That is, when the wheel *A* is fixed and the arm makes one revolution in a counter-clockwise direction, the wheel *B* makes three revolutions in the same direction.

Now let us take the last case given by Mr. Bostock in Vol. 30, Part 1, page 692. Two central gears are shown with 90 teeth and 91 teeth respectively. Both are drivers. One arm carries two planetary gears, and there are two internal gears; one with 120 teeth and fixed, the other with 121 teeth and driven. See Fig. 3.

Tabulating in the two stages as before, we get:

	Wheel of 90 Teeth.	Arm.	Wheel of 120 Teeth.	Wheel of 121 Teeth.
Arm fixed.....	1	0	$-\frac{91}{120}$	$-\frac{91}{121}$
Wheel of 120 teeth fixed..	$1+\frac{91}{120}$	$\frac{91}{120}$	0	$\frac{91}{120}-\frac{90}{121}$

Therefore the ratio of reduction=

$$\frac{\textit{90-Toothed Wheel revolutions}}{\textit{121-Toothed Wheel revolutions}} = \frac{1+\frac{91}{120}}{\frac{91}{120}-\frac{90}{121}} = 121.$$

That is, while the wheel of 90 teeth makes one revolution, the wheel of 121 teeth makes $\frac{1}{121}$ revolution in the same direction.

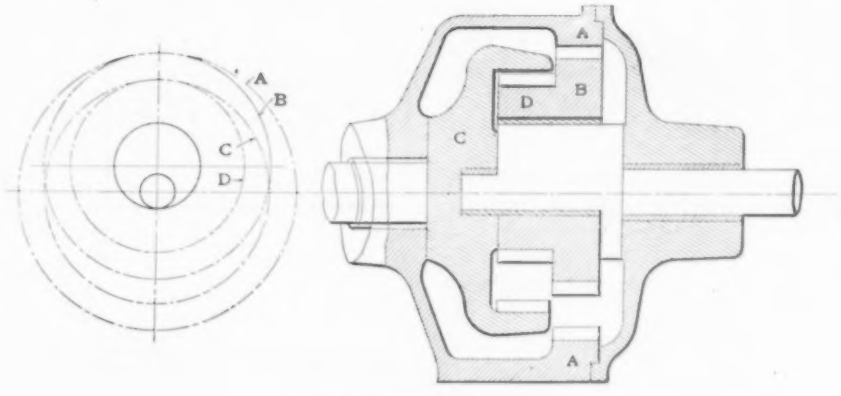


FIG. 4. THE ROSS GEAR

The Ross Gear is another case of epicyclic gearing which we might consider with profit.

The internal wheel *A* is fixed. The internal wheel *C* is driven. The pinion *B D* rides loosely on the eccentric shaft, or what we will call the arm. The eccentric shaft is the driver. Tabulating as before, we get:

	Wheel *A*.	Arm.	Wheel *C*
Arm fixed	+ 1	0	$+\left(\frac{A}{B}\times\frac{D}{C}\right)$
Wheel *A* fixed..	0	− 1	$-\left(\frac{1-AD}{BC}\right)$

Ratio of reduction $=\frac{BC}{BC-AD}$ in the same direction as the arm or eccentric shaft. Or for one revolution of the arm or eccentric shaft the wheel *C* makes

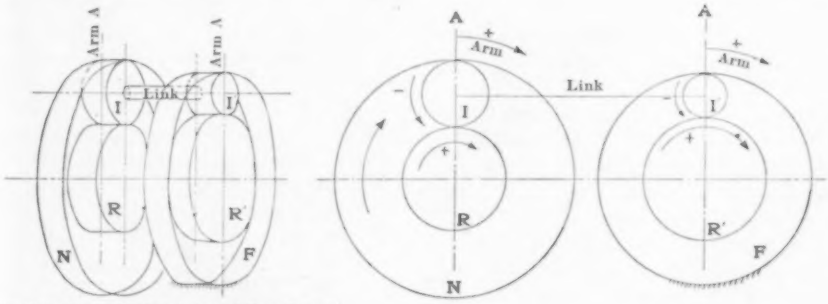
$\frac{BC-AD}{BC}\left(1-\frac{AD}{BC}\right)$

revolutions in the same direction.

S. MILLS.

M——, England.

Correction see p 915



An Epicylic Train Consisting of Two Central Gears, One Arm carrying Two Planetary Gears, and Two Internal Gears. One of which is Fixed.

FIG. 3. ANOTHER PROBLEM IN EPICYCLIC GEARING

Some Failures and Successes in Bending Dies

The accompanying engravings show how the best results were obtained on a couple of bending jobs. Figs. 1 and 2 represent the articles to be bent, in both blank and finished form. Both were made from cold-rolled stock. The tools for bending the part of Fig. 1 were first made as shown in Fig. 3. This method, however, had to be discarded, as the work produced was not uniform. It will be seen by referring to the drawing of the article that it must be bent in two different directions across the blank at the dotted line drawn near the corners. The end of the blank which is pierced by the large hole must be bent upward and the sides of the other part bent downward, as shown in Fig. 1.

Referring to Fig. 3, it will be seen that the part of the punch to strike the blank first is exactly opposite the corners of the blank. In operation this tended to slide the blank backward, thus causing the blanks to bend across what might be termed the neck. It will also be seen that the back end of the blank rests on a round corner. This allowed the blank to slide sideways and, in conjunction with the backward slip, gave the piece a misshapen, twisted appearance. A spring plunger was fitted to the die with little or no benefit to the result.

FIG. 1. A BLANK AND THE FINISHED PIECE

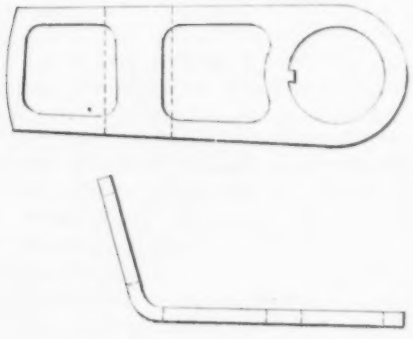


FIG. 2. BLANK AND FINISHED PIECE FOR A CYCLE LAMP BRACKET

The dies were then discarded and new ones constructed as shown in Fig. 4. This proved to be very successful; the work was correctly formed and was uniform. In operation the blank was placed in the die with one of its sides in contact with the plate on the side. The blow was then struck. It was thought at first that a spring would have to be provided at the front, to hold the blank against the plate, but this was found to be unnecessary. The same principle was afterward successfully applied to several other jobs.

Fig. 2 represents a cycle-lamp bracket. This, it will be seen, must be bent across the blank midway between the two rectangular piercings. Some blanks, not pierced, were supplied to the diemaker from which to make his dies while the toolmaker finished his piercing tools. The sample blanks, when bent, were all that could be desired. The dies had been made as shown in Fig. 5, but without the plunger. When, however, the blanks had been pierced and came to be bent, the results were not satisfactory. The blanks would bend at either one or the other side of the bar, as shown by the dotted lines in Fig. 2.

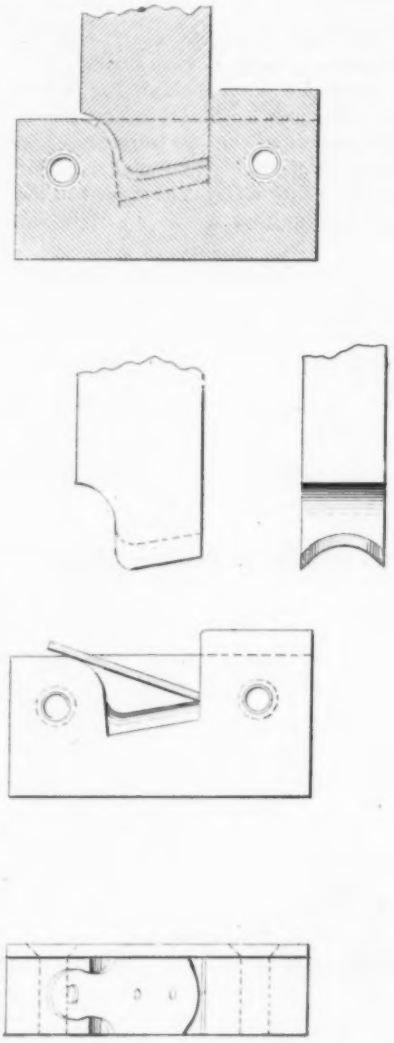


FIG. 4. THE SUCCESSFUL BENDING TOOLS FOR THE PIECE SHOWN BY FIG. 1

The spring plunger was then fitted as shown in Fig. 5, which is a side elevation of the tools in the closed position with the work. This mended matters considerably, as the work was correctly bent and the results were uniform. It was found, however, that the sharp corners of the plungers marked the work. This would not do, as the work was polished for plating before being bent. Reference to Fig. 6 will show that a great deal of the actual bending is done on the sharp corners. It was finally decided to anneal the die and plane it off as shown by the dotted line, Fig. 5. This was done and the plunger was driven in tight with its corners ground off. This was then found to be quite the thing. The work was not marked nor marred in any way, and the results were uniform.

In operation, the work was placed in the front part of the die, which was provided with gages, as shown in plan, Fig. 7. It was then struck and moved over to the other half of the die and another blank placed in the gage, so that after the first blow a blank was both bent and planished at every blow.

WILFRED GEORGE.

Repairing Micrometers

My advice to young fellows attempting to repair(?) micrometers is to stop and consider that when any micrometer has seen usage enough to cause the contact faces to become "badly worn," it has also lost its truth in the thread and is fit only for the junk heap, unless it is used on very rough work and the worn contact faces are good enough.

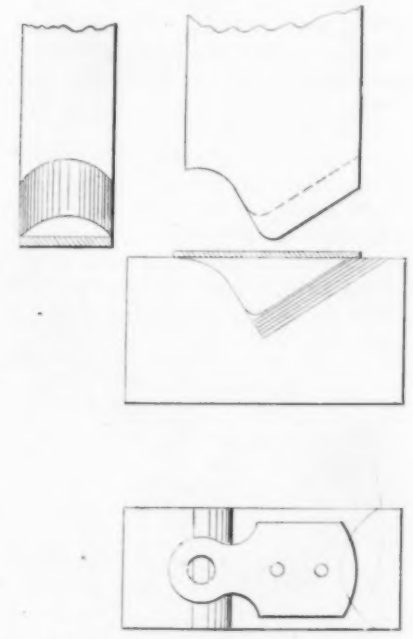


FIG. 3. THE UNSUCCESSFUL BENDING DIE FOR THE PIECE SHOWN BY FIG. 1

True, the nut can be adjusted to fit nicely on the high spot of the screw, but that does not remove the backlash in the worn part; consequently the micrometer has lost its truth and no amount of time spent on the faces will make the tool measure accurately the entire length of

travel of the spindle. The method as set forth by Mr. Pierce is much quicker than Mr. Norton's method, but it lacks the first atom of accuracy. In the first place, a toolmaker worthy the name would never think of buying an old worn-out "pair of mikes," as the micrometer is the most important and most cared for tool in his kit. At the first sign of wear it is replaced by a new one.

To show how utterly impossible it is to "repair" micrometers in the manner described by Mr. Pierce, on page 492, I call attention to the first operation. Mr. Pierce's friend opened the "mikes" a trifle more than 3/16 inch and locked the spindle with the clamping device. This caused the spindle to cock up, placing the face of the spindle on an angle with the anvil. He then lined the mike with a feeler as accurately as possible to run parallel with the face of wheel. To produce true work the work should be lined to travel parallel with the travel of the bed. Never mind that, the point I want to bring out is that I know that it is impossible to line up a ¼-inch face with a feeler as accurately as possible. Granting that the mikes were lined up absolutely accurate and the faces ground, upon loosening the clamping nut the spindle returns to its natural position, which places the face of the spindle on an angle. This is a nice condition under which to make a limit gage having 0.0001 inch limit. The wheel will also leave ridges no matter how carefully we work. We all know this, else we would not be obliged to lap our gages, but could use this special brand of ridgeless wheel. Granting that there are ridges in the faces of the anvil and the spindle, and considering that the spindle has a rotary motion, I can almost imagine these ridges catching in similar ridges in the work, causing the ratchet to slip, if the ratchet is depended upon for fine measurements. Toolmakers, as a rule, prefer to depend rather upon their practised sense of touch than on the varying ratchet due to—but I am allowing my mind to travel away from truing up a ¼-inch face with a feeler, lining up the mike so that it is true with the face of the wheel, attempting to obtain parallel jaws by cocking a badly worn spindle all over the lot with a clamping nut and setting the face of the spindle at right angles to within 0.0001 inch by means of sparks from an emery wheel, which vary with the grade and speed.

Summing up the whole job, my advice to the young fellows is to "cut it out." Possibly these repaired mikes were to be used for measuring castings; if so, I have nothing to say as regards the method, but would warn the user to be careful, as the molder may change his sand and sand often varies 0.0001 inch.

FRANK E. SHAILOR.

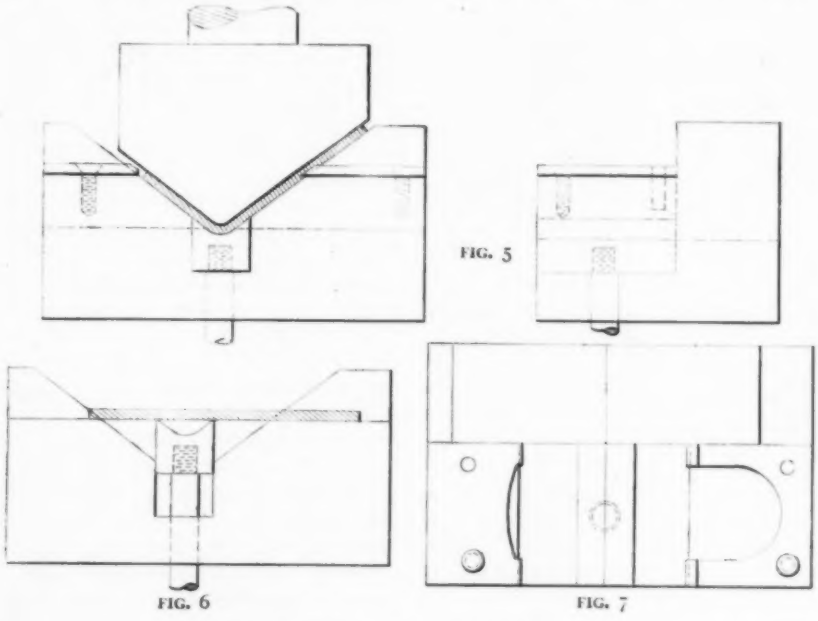


FIG. 5

FIG. 6

FIG. 7

BENDING DIES FOR THE CYCLE LAMP BRACKET

Being somewhat interested in micrometers, their manufacture and repairs, I have read the various ingenious schemes for making them as good as new, as put forth by Mr. Uber, page 206, Mr. Pearce, page 492, and Mr. Cameron, page 493. My candid advice to any toolmaker, no matter how clever, who has a similar job to do is, let the manufacturer do it for you. They will fix your "mike" so it will be accurate and dependable if it is not actually reduced to scrap, and you can't compete with them in price.

Does it need a new screw? Their expert repair man can tell about the time he gets hold of it; and if it does, he has a stock of them ready cut (on a special machine), the spindle ground and lapped and the end also lapped *absolutely* at right angles with the axis; not pretty near, but right there. If it is not, it goes back pretty quick when tested, to be done over. If the bushing is loose, out it comes and a new one takes its place; no paper here. The anvil is worn; it gets swapped for a new one, cheaper than fixing the old one.

Then when the parts are once more assembled, they are put to the same tests as new work; any "mike" not actually worn out can thus be given a new lease of life and usefulness at a nominal cost.

W. H. DRURY.

Visiting Your Own Shop

While most large firms in this country have their visiting and social society, I don't suppose any of the members would like to propose a visit around their own works. But when the idea is considered closely, the present order of commercialism admits very little knowledge of one's own firm, and a turret hand, or even toolman, has not the liberty to travel around on his own free will and so may not know any more than his own department, or not even that.

Other firms and societies desire to visit your workshop, and some go to some considerable trouble and expense to give you a visit. They go away with glowing accounts of what they have seen, and both you and they are benefited. The idea worked so well at our shop that there had to be three days set apart for it. The general idea was that a Saturday afternoon was not being mis-spent in viewing your own shop and being shown the various classes of work by the men in charge. The suggestion will no doubt be received with smiles, if not worse, but all will be satisfied by the information received during the inspection.

England. E. GREGORY.

Cooperation and Harmony

"Coöperation as an Element in Factory Organization," at page 417, interested me. It is an unfortunate fact that quite a number of men occupying responsible positions are unfit to fill them, both mechanically and as to organizing to get results. This is particularly true when a manager or foreman is afflicted with a swelled head and thinks he is the great "I am." To be a good employer, manager or foreman is, in a manner, a calling in itself, as a good many are not gifted in this way. Harmony and good will among men should always prevail in any well regulated concern. The worst afflictions among employers, managers and foremen, and particularly employees, are petty jealousies, with a mixture of ingratitude, which should be controlled and curbed. With such afflictions, success is impossible. Employer and employees should work hand in hand without any antagonism.

It is exceedingly unfortunate that an

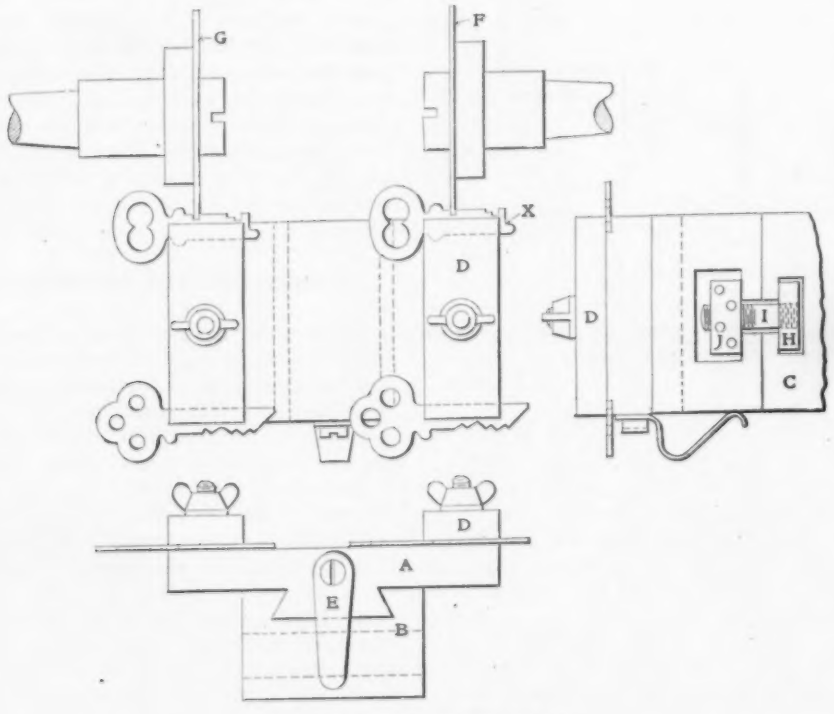
employer cannot show appreciation of good services by kind treatment and proper compensation, to encourage worthy employees, without breeding discontent among the poorer workmen.

HERMAN FLETCHER.

A Key-cutting Attachment for a Foot Lathe

Sixty-two years ago, in England, three boys were playing with gunpowder. One of them, a boy of 9, lost both hands halfway up to the elbows. Like his father he was mechanically inclined, and although thus handicapped has since made a living as a gun and locksmith and general repairer and raised a large family. This old gentleman is now 71. His name is Henry Code, and his shop is in Evanston, Wyoming.

Mr. Code designed the key-cutting attachment for his lathe and, without hands, built it. The table *A*, to which the keys and key blanks are clamped by the clamps *D*, has a slide which permits it to be pushed toward the cutter *G* and guide blank *F*. The lower part of this slide *B* is secured to the tool slide of the lathe by means of two studs *I*, a bar *H* and two pilot nuts *J*. A spring *E* brings the slide *A* back to position. A gib, not shown, can be tightened so that the slide *A* will not move.



A KEY CUTTING ATTACHMENT

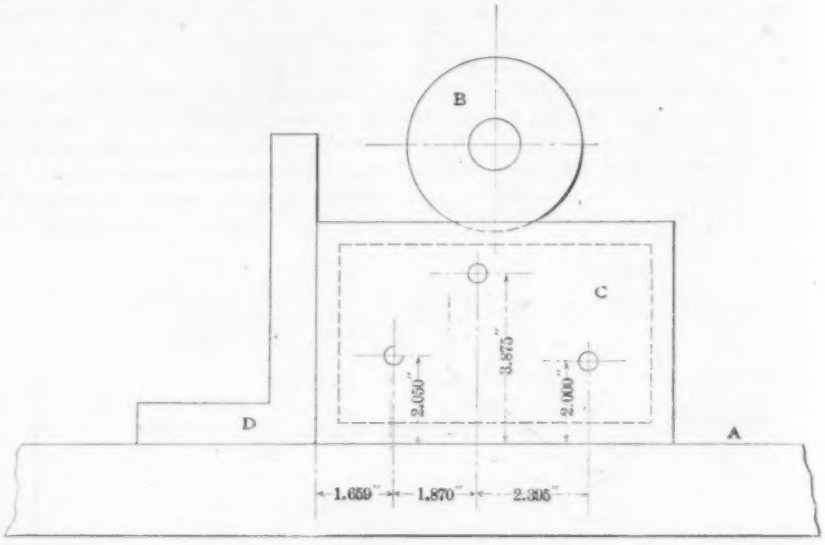
The operation of the device is as follows: A saw *G* is mounted in the live spindle. A blank disk *F*, the same size and thickness as the saw, is put in the tail spindle. The key is put opposite *F* and the blank opposite *G*. The carriage is moved along till the depression *X* is opposite *F*. The slide *A* is then pushed forward, the saw *G* cutting a similar depression in the blank. The next depression is then cut, the guide disk *F* locating and gaging the depth of each depression, and so on till the key is finished.

For yale keys an emery wheel is used, turned to the proper angle with a corresponding disk as a guide. The longitudinal feed is thrown in and the cross slide pressed up to the work. This device was designed by Mr. Code for his own use; of course for a man having hands, the device could be modified.

WIT BECK.

Boring Holes in Jigs and Similar Work without Laying Them Out

In jig work as well as in all up-to-date tool work we want accuracy, so that when we speak of one inch we mean an inch and not one or two-thousandths under or over. In boring out holes in a jig or in experimental or other close work we can locate all holes to be bored on the miller or boring mill by the aid of the hight gage exclusively.



A JIG JOB ON THE MILLER

Let us consider a simple case as shown in the sketch. Let *A* represent the platen and *B* the spindle of a miller. *C* is the jig fastened on the platen and lined up correctly with the spindle. Alongside of the jig we also fasten on the platen an angle iron *D* which is lined up with the spindle. In the spindle we insert a one-inch plug which must run true. We are now ready to take the first measurement. The drawing calls for the first hole to be 1.659 inches from the side of the jig. As the angle iron is close to the jig we take our measurements from here instead. The plug in the spindle is 1 inch; one-half of it, 0.500 inch, we must deduct from our measurement; 1.659 inches — 0.500 inch = 1.159 inches, to which size we set the hight gage. We then move the platen until we just slide the hight gage between the angle iron and the plug in the spindle. Having secured this measurement we lock the platen in the usual way. Next we need the hight of the hole, which is 2.055 inches; we deduct 0.500 inch for one-half of the plug and set the hight gage to 1.550 inches and move the knee of the miller until we can just pass the hight gage between the platen and the plug. When this is done the center of the spindle is directly opposite the intended hole, which we now proceed to bore in the usual way. Having finished the first hole we find the position

for second one in a similar way. We unlock the platen and disregard our former measurements altogether. The second hole calls for 1.659 inches + 1.870 inches = 3.529 inches — 0.500 inch for half of the plug; hence we have 3.029 inches, to which we set the hight gage. We move the platen until the hight gage just passes between the angle iron and the plug and this is our distance for the second hole. The platen is now locked again. The hight of the second hole is 3.875 inches — 0.500 inch for the plug allowance, which gives 3.375 inches, to which we set the hight gage and then move the knee of the miller until the gage passes between the platen and the plug in the spindle. We have now set correctly for the second hole to be bored. The third hole is positioned in the same fashion. The measurements are 1.659 inches + 1.870 inches + 2.395 inches = 5.924 inches — 0.500 inch for the plug, so we set the hight gage to 5.424 inches and it must just pass between the angle iron and the plug in the spindle to bring the jig in line for the third hole. For the hight we have 2.000 inches — 0.500 inch for the plug; the gage is set 1.500 inches and must pass between the platen and the plug. The center of the spindle is now opposite our third hole.

In this manner the work is set for all the holes direct from the drawing and we would not think of using the old-time button method for handling this class of work on the miller or boring machine.

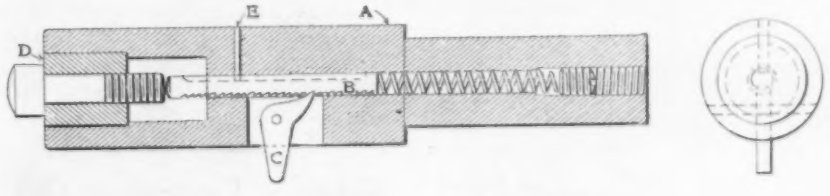
In cases where the distance is greater than the reach of the hight gage will cover, we take the measurement from any convenient hole bored, by inserting a plug and then measuring from the plug in the jig to the plug in the spindle, making due deduction for one-half of both plugs. Or we can lay parallels along the angle iron, etc. Circumstances will show the way to take the correct measurement readily as long as one is handy with the hight gage. If you get used to this hight gage you will want no other measuring instrument for laying out work properly. Our hight gages are in as much demand as our common twist drills, and we cannot get along without them. The setting of a jig for boring, however, is one thing and the boring another, and needs as much care, if not more, to secure accuracy.

The placing of the angle iron alongside of the jig is merely to facilitate measurement and any other flat surface which overlaps the width of the jig will do just as well. The idea is to have a permanent surface for a starting point to measure from. The plug in the spindle can also be of any size so long as we deduct one-half of it from our measurements.

FRED. H. SANDER.

A Screw Holder for the Turret Lathe

The device is used in the turret of the automatic screw machine for holding screws while they are being cut from the bar, retaining them while the head is slotted, and automatically ejecting them, positively, at a given position of the turret. The fixture which it replaced was limited in its range, for it discharged only short screws. The tool shown in the sketch is limited in its range only by its original length and the discharge is positive. Another objection with the former fixture was that it dropped the screws among the chips and oil below the turret, making their removal inconvenient.



A SCREW HOLDER FOR THE TURRET LATHE

The body *A* is drilled, tapped and slotted as shown and the smaller end turned to fit the hole in the turret. The plunger *B* is notched and held in place by the pawl *C*, which is pivoted in the slot in the body. In the central hole, behind plunger *B*, is placed a spring, the tension of which is varied at will by the screw in the rear. The pin *E* acts as a key for the plunger *B* and prevents it from turning, thus keeping the pawl in line with the notches. This pin also acts as a stop to prevent the pin from going too far forward. The bushing *D* fits the counterbore, as shown, and is drilled slightly larger than the diameter of the screw it is intended to hold. This hole is beveled at its inner end, thus allowing easy entrance of the rod.

In operation the tool in the turret advances toward the screw which is ready to be cut from the bar, and the threaded end enters bushing *D*, pushing the plunger *B* back until the head of the screw nearly abuts the bushing when the turret stops. Thus the spring is compressed and the plunger is held in place by the pawl. When the screw is cut from the bar and has been slotted, the tool passes a projecting cam, which comes in contact with the pawl and, on releasing it, the spring forcibly ejects the screw into a hopper (an old tin spout was used in this case), which delivers the work to a pan on the floor. When the pan is full, another one replaces it and it is set aside to allow the oil to drain till the screws are in convenient shape to be transferred to the stock room.

L. F. BENJAMIN.

Rough Shop Gages

Perhaps Osborne—if to so versatile a mind anything can be new—will be interested to know that gages have been designed particularly adapted to correction by that "barbarism" peening.

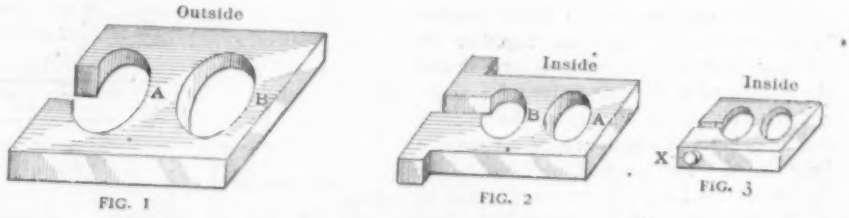


FIG. 1 FIG. 2 FIG. 3

ROUGH SHOP GAGES DESIGNED FOR CORRECTION BY PEENING

Sketches show the way I used to make my own rough gages. Peening at *B* corrects them when worn. Peening at *A* will negative overshooting of the mark in aiming at correction.

Two pegs *x*, Fig. 3, enable the inside gage to be made from flat bar stock.

FRANCIS W. SHAW.

England.

Elevator Protection

In our shop we have twice within a year narrowly escaped decapitating men who persisted in looking down the elevator shaft when the elevator was coming. On account of the hight of some of the machinery we have to move on our elevators we cannot use firedoors which slide vertically, and as they are in constant use it is too much trouble to keep opening and shutting the horizontally moving doors. On that account we have frame gates which afford protection from falling into the shaft and the top of which come about the hight of a man's chin. The last man who was injured looked over the top of the gate to see if the elevator was below and the descending elevator struck the back of his head. The operator stopped quickly enough so that all he got was two months in the hospital. To guard against future accidents the company had

signs printed which read in letters 4 inches high:

DO NOT LEAN
ON
THIS GATE

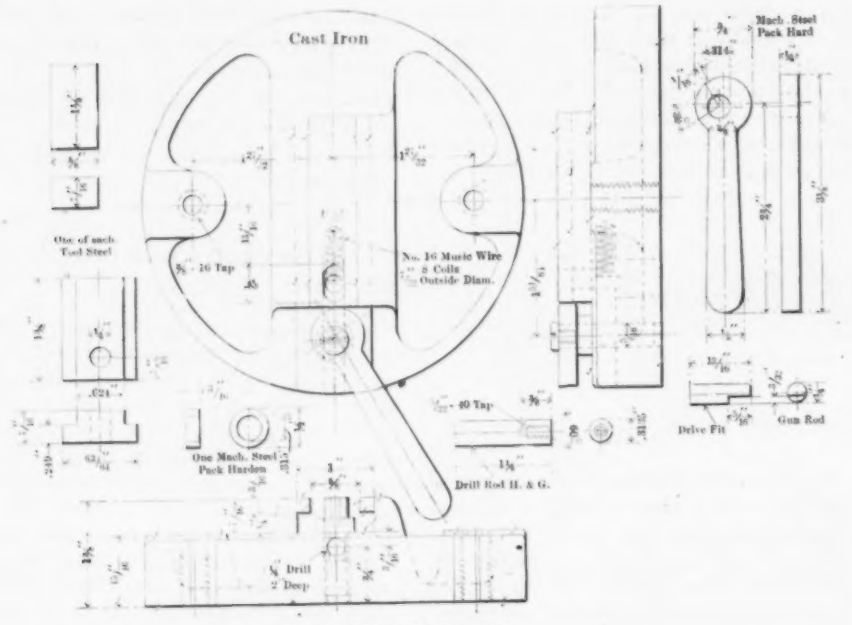
In addition to the above a quantity of 1½-inch angle iron was procured and cut up in pieces as long as the various elevators were wide. In one side of these pieces were drilled and countersunk holes for screws. In the other side were drilled ¼-inch holes every 5 inches into which 3-foot lengths of dog-chain were fastened. The pieces were then screwed onto the bottom of the elevators as near the front as possible, and act the same as a low-bridge signal on the railroad. We have not had an accident since.

JOHN A. EARLY.

A Riveting Fixture

In our work we have a great number of pieces that are fastened together by riveting, and in the drawing are shown the details of a riveting fixture for application to either the Prouty or the Shuster machine, both of which are, of course, for light work. The method we employ for this work is applicable to any class of work where a number of pieces of irregular shape have to be handled.

The fixture itself is nearly self explanatory, consisting of a cast-iron plate, recessed to conveniently hold a number of the parts being riveted together, and a cam lever actuating a moving jaw, which



A RIVETING FIXTURE

is returned to place by a spring acting against a post driven through the jaw, as shown.

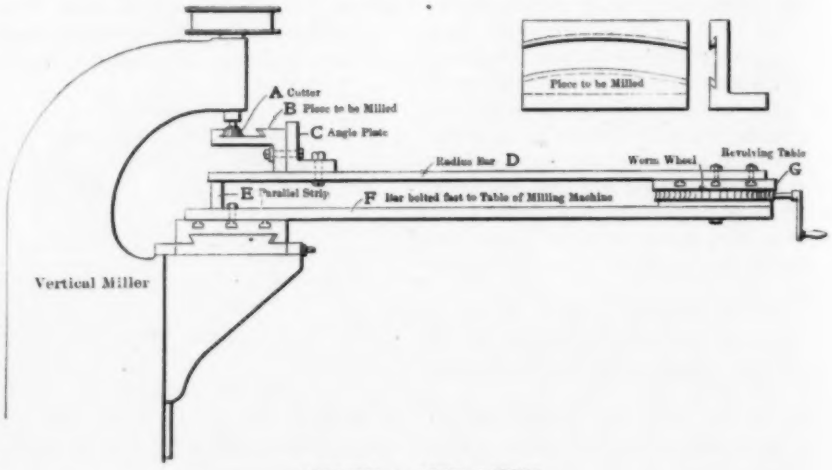
The desirable feature of the fixture is that the parts comprising it may all be made in quantities, all that is necessary to fit a fixture for a new piece being to give the jaws the required shape, harden them and assemble. The smaller or stationary jaw is, of course, fastened to the base by a screw and dowels, which are not shown on the drawing. M. R. CRITIC.

Milling with a Long Radius

Not long ago we had occasion to make a dovetail slide to move on a radius of about 5½ feet, for use in a jig. We had no lathe nor boring mill that was anywhere near large enough to turn it, and the accompanying sketch shows the way it was done.

A stout bar *F* was bolted securely to the table of the vertical milling machine. On the outer end of this bar was fastened a table *G* which could be revolved by hand. On this table was bolted a radius bar *D*, the inner end of which rested on a parallel strip *E*, of the right thickness to support it in a level position. An angle plate *C* was bolted to *D*; to *C* was bolted the piece *B*, in which the curved slide was to be milled.

The cross slide of the milling machine, shown in the sketch, afforded means of setting the work up for another cut. By taking several cuts the work was finished successfully and a good job was made of it. W. ALTON.



MILLING A LONG RADIUS

An Emery-wheel Stand

On page 379 appears an illustration and description of an emery-wheel stand, in which I am very much interested; but there is one point I cannot quite understand. "The taper bushing is milled through to allow take up." Does that mean it is split from end to end by the slot shown? If so, that seems to me unnecessary, for if the bushing is parallel on the outside, the "take-up nut" will simply pull the sleeve or bushing on to the taper part of the axles, and thus take up what is necessary. Besides, if the slot were from end to end, it would allow oil to escape at the ends instead of into the reservoir. W. GILDERT.

[The drawing and description are not clear on this point. Perhaps J. Brown will clear this up.—ED.]

Making a Counterbore Quickly

I have been interested in your articles on making counterbores and cannot refrain from sending you an actual experience of mine which happened recently. Our counterbores were of the old-fashioned flat-drill pilot style, and were completely played out. There was no machine out of use on which to make any elaborate-style counterbore as shown by your contributors, and as the work had to be done in a hurry it was up to me to get it out on time.

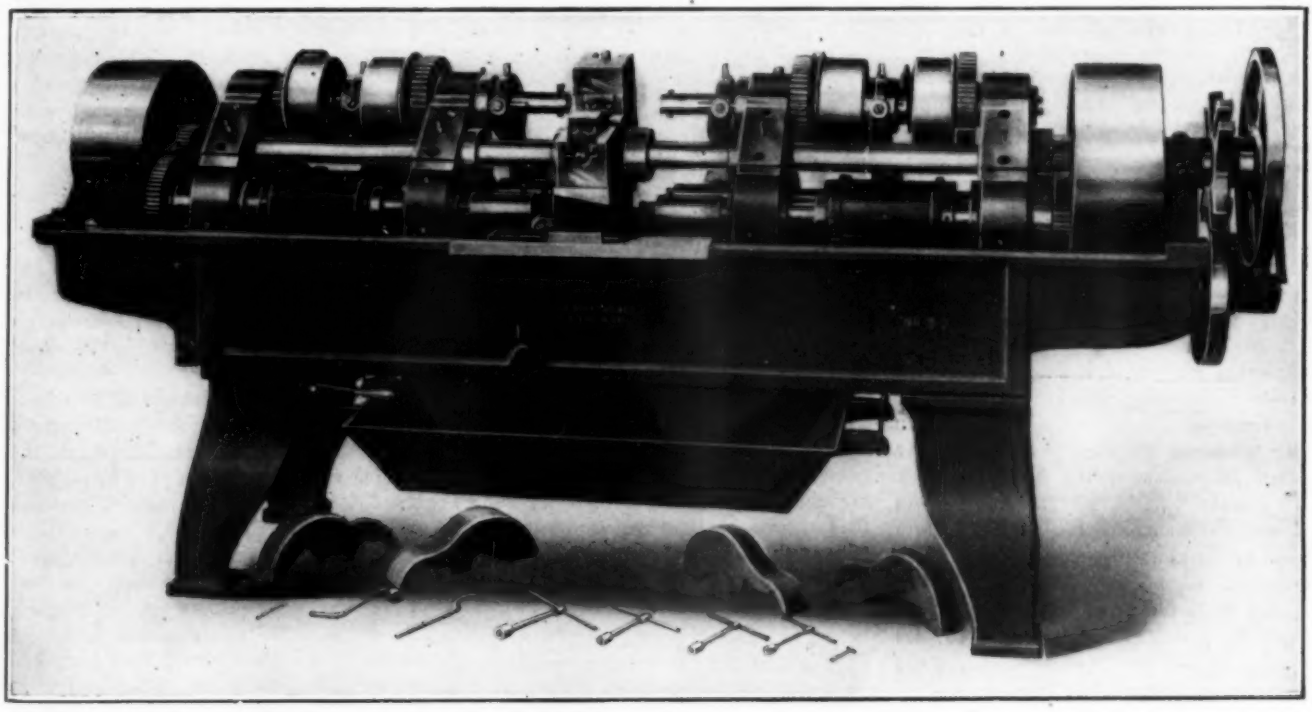
The work to be counterbored was for ½-inch cylinder head screws, with heads 13/16 inch in diameter and ¼ inch deep. The ½-inch holes were drilled as usual

and the counterbore drilled ⅛ inch deep with a 13/16 drill. I then ground an old 13/16-inch drill square on the end, with clearance as usual for keyseating work, and this finished the counterboring in less time than it can be done with many expensive tools, in spite of the three operations necessary.

The worst trouble with most counterbores is keeping them sharp, but this is easy with this style; the expense is practically nothing, as all shops have old drills in large quantities. My motto is to use up what others throw into the scrap pile, and to make no elaborate tools that can be avoided. A. N. HAMMOND.

Double-head Multiple-spindle Automatic Turret Machines

At page 748, Vol. 28, Part 2, we illustrated the multiple-spindle automatic turret machine built by Geo. G. Prentice & Co., New Haven, Conn., and we now show a double-head machine of similar design built by this company.



SIX-SPINDLE DOUBLE-HEAD AUTOMATIC TURRET MACHINE

This machine performs boring, facing, drilling, turning, threading and other operations on both ends of a piece at one setting in the chuck. The standard machine has three spindles in each end, between which is a chuck having four sections or sets of chuck jaws. The spindles, carrying the tools, are in line with the different sections of the chuck, except the upper section, where the operator removes finished work and inserts an unfinished piece while the machine operates constantly on a piece of work in each of the other sections of the chuck.

The spindles revolve and are fed up to the work by means of yoke and lever connections with cams on drums inside of the bed, the cam shaft extending the entire length of the machine. The forward-feed cams are set at the proper angle to give the required advance or cutting feed to the tools on the work, and the reverse cams draw the tools back from the work when the operations are completed. While the tools are backing off, the chuck is automatically indexing so that each piece of work is brought in line with the spindles which perform the succeeding operations.

The movements of the machine are timed so that the indexing occurs as soon as the longest single operation on any piece of work is completed. All the shorter operations are completed within this time, hence the time of finishing a piece of work on both ends is the time necessary for the longest single operation plus a few seconds taken in the indexing of the chuck and the advancing of the tools.

As the chuck indexes toward the front of the machine, the first or roughing spindles are at the front, and the finishing and threading spindles follow. The threading mechanism consists of a sliding tap or die holder with a fork lever connecting with a cam to start the lead of the thread. The driving mechanism consists of forward and reverse friction pulleys with expanding rings. The tap is driven the required number of turns into the work, then the reverse is automatically engaged and the tap withdrawn.

The proper cutting feed for different kinds of metal is obtained by change gears, a worm and worm gear connecting with the main feed shaft on which all cam drums are placed. The spindles are back geared and have ample driving power for work within the rated capacity of the machine.

Three sizes of the six-spindle machines are built: One for light work, one with capacity for ¾-inch pipe size threads and smaller, and one for 2-inch down to ¾-inch pipe threads. The same design of machine is also built with four spindles in each head and a five-section chuck, the three sizes of this design corresponding in threading capacity with the three six-spindle machines. The eight-spindle type is adapted especially to handling bicycle hubs and gas and electric fixture work. All these machines have the same chuck-steadying bracket as the single-head machine illustrated two years ago.

The excess of imports over exports for the United Kingdom was £188,000,000 for the year ending July 31, 1904, and £137,000,000 for the corresponding time ending July 31, 1907. The net imports, excluding £93,622,000 re-exports, were of the value of £545,794,000 and the exports £408,406,000, showing an increase in three years of 13 per cent. in imports and 40 per cent. in exports.

A report on the gold values in the Klondike high-level gravels, by R. G. McConnell, geologist for the Dominion of Canada, states that the value of the gold already taken from this district amounts to $119,000,000, and the estimated value of the amount yet to be mined is $65,000,000.

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Inefficient Machine-shop Lighting

The modern tendency in machine-shop building design is toward very large window areas and other provisions for the best of natural light over the manufacturing area. Yet natural light is not available for a considerable part of the working year, a rough average being perhaps 15 per cent., exclusive of over-time work. Have provisions for artificial light to care for this 15 per cent. of the working year kept pace with the advance in admitting natural light?

Of course, electricity is the illuminant which is used almost universally today in machine shops. Yet in how many cases do we see inefficient installations. It is quite generally conceded that the best manner to work out such lighting is through the use of high candle-power units, as arcs, or large incandescents for general lighting over the entire working area, and the addition of individual incandescents for the various machine tools. The majority of machine operations are such that the workman needs a concentrated light, adjustable, over the working area of his machine, so that it can be projected upon the point at which tools are being set or work is being gaged or measured.

The general illumination is usually better worked out and installed than the individual. In many cases the individual light consists of a drop, provided with a guard to prevent breakage of the lamp, but without reflector or shade. A lamp used under these conditions is inefficient in that the light is not brought to the point at which it is required; in that, lacking a reflector, a great deal of the light is diffused over a space where it is valueless instead of being concentrated upon the work, and, lacking a shade, the workman naturally fastens around it a piece of heavy paper, or other material, to shield his eyes, which still further cuts down the amount of light given. Again, the bulb is often spattered with oil or soiled by grease or dirt, so that it is not at all uncommon to find lamps which give less than one-half of their normal candle power, and this entirely through lack of care.

In how many shops do we see the lighting pendants tied over by a piece of string to some part of the machine tool, or supported on roughly made brackets, with their shades or reflectors bent and dirt covered, and showing only too plainly that little attention has been given to the question of proper installation or of upkeep! When we consider the thousands of dollars which are spent to provide the best of natural light throughout the period of the year when it is available, is it not grossly illogical to neglect the artificial lighting during that portion of the year when it must be used? A good machinist earns, say 30 cents an hour, or one-half a cent a minute. Is it economy to fail in providing an all important element to the success of his labors for, say, 15 per cent. of his working year?

Our criticisms apply more particularly to the individual lighting for the various machine tools. Such lighting should be by means of lamps carried on adjustable fixtures, or other support, so that the entire working area can be covered at the will of the operator. The light need not be of high candle-power, but should be provided with a suitable reflecting shade and guard and should be kept clean.

Another point for consideration is the life of the lamp. In a machine shop the greatest lamp loss is from breakage; still many lamps are often burned beyond a point of efficiency, as usually no one thinks to consider the candle-power which a lamp is giving, but continues to use it until it either burns out or is broken.

Again, how often is the voltage tested at individual lamps to see if it is right? If too low there is a decided loss of light; if too high the lamp life is being rapidly shortened. The lighting period for the approaching winter season is now well begun, and a consideration of various installations will show many of the points of inefficiency which we have mentioned.

Universal System of Machine Molding

An interesting paper, "Universal System of Machine Molding" was presented before the New York Railroad Club at the building of the Engineering Societies on the evening of October 18, by E. Ronceray, of Paris, France.

A number of magic-lantern slides of various machines were thrown on the screen and explained by E. H. Mumford, the molding machine builder, of Philadelphia. These were followed by moving pictures showing the making of molds on various types of French machines. Probably the most interesting and comprehensible motion pictures were those presented last. A pair of hands would appear holding a casting which they would turn over and over, exposing all parts of the casting to view, at the same time the number of pieces molded per hour, would appear at the bottom of the screen. To many this way of showing the production of the machine, appealed more directly than could have been done in any other manner.

The method employed has many distinct advantages over even a demonstration with a machine in a foundry. There is no noise, dirt, smoke or smell and the same space (the screen) can be utilized to show any number of machines or operations. It is surprising that moving pictures are not more universally employed to show the working of machines such as automatic screw machines and machines of a similar intricate nature.

New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A 26-inch Turret Lathe

The illustration shows a 26-inch boring, forming and turning lathe with turret head.

By means of the lever on the head below the cone pulley six changes of feed are instantly obtainable without changing the belt on the cone pulleys.

The top of the bed is provided with slots to accommodate stops for the turret. By the use of these adjustable dogs set in the slots the turret can be tripped at any additional point on the bed independent of the trip arranged for any other face or faces of the turret.

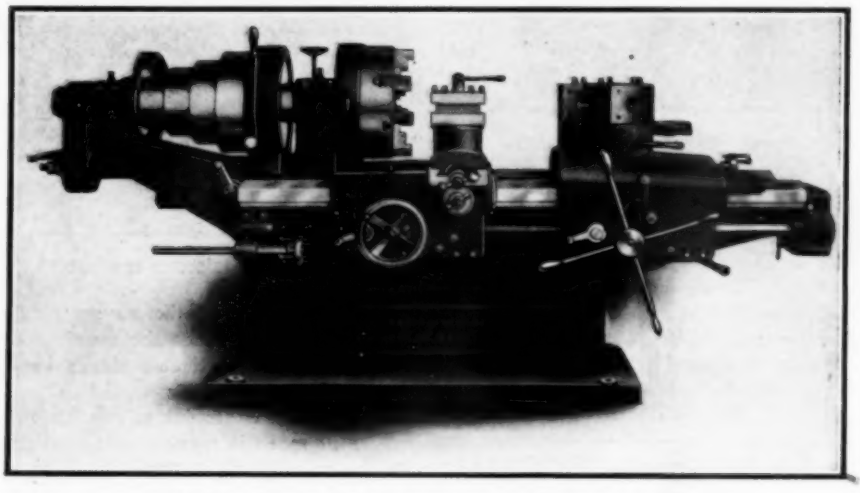
The change gears for thread cutting are located at the tail end of the bed and are covered by a swinging door. When the door is swung open, the gears can be removed and others put in their places without the use of a wrench. The door holds the gears in position when it is closed.

The lathe will cut all threads from 2 to 32 per inch with either the carriage, ram or cross slide.

A lever, not shown, arranged to be operated by foot, is used to reverse the carriage and ram.

The carriage has an automatic trip by which each of the four sides of the cross slide turret is stopped.

The turret is 14 inches diameter and has six 2½-inch holes. The greatest distance between the face of the chuck and the face of the turret is 47 inches. Long work can be passed through the turret.

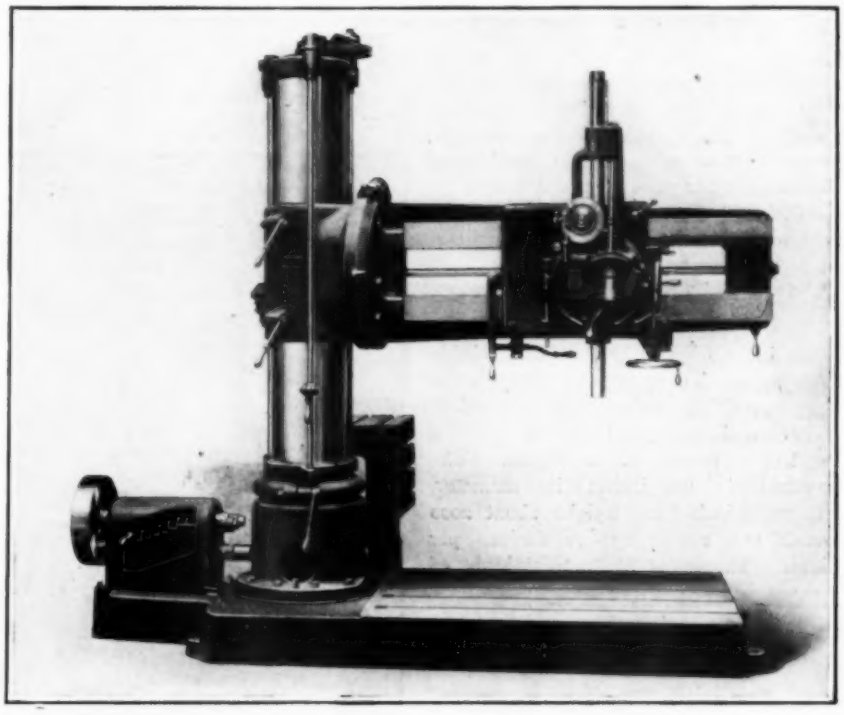


26-INCH TURRET BORING, FORMING AND TURNING LATHE

This machine is built by the W. P. Davis Machine Company, Rochester, New York.

A Universal Radial Drill

The half-tone illustrates a new line of universal radial drills. The sleeve is mounted on a stationary stump which extends up to and has a bearing at the top of the machine. The arm may be rotated through a complete circle on its girdle and the head through a complete circle on its saddle, which permits drilling at all angles radiating from the center of a sphere. The back gears are located back of the saddle and may be engaged or disengaged from the front of the machine; while running, they furnish three changes of speed. The spindle has 15 changes of speed with the cone drive and 24 with the gear drive; it is provided with both hand and power feed, quick advance and return, safety stop, automatic trip, dial depth gage and hand-lever reverse. A plate attached to the speed box shows how to obtain the correct speeds for different diameters of drills.



A RADIAL DRILL

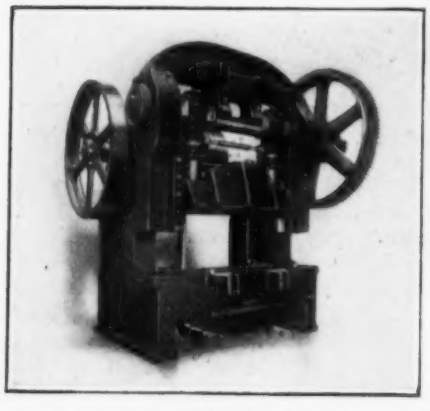
The depth gage, besides enabling the operator to read all depths from zero, supplies a convenient means for setting the automatic trip, the graduations showing exactly where each dog should be located in order to disengage the feed at the desired points. The automatic trip operates at as many different points as there are depths to be drilled at one setting of the work; in addition, it leaves the spindle free, after any intermediate tripping, to be advanced, or raised and advanced, or traversed its full length, without disturbing the setting of the dogs; it also throws out the feed when the spindle reaches its limit of movement. The feeding mechanism furnishes eight rates of feed, ranging in geometrical progression from 0.007 inch to 0.064 inch per revolution of spindle, each of which is

instantly available. A plate attached to the head shows the operator how to obtain each of the feeds.

The tapping mechanism is located on the head and permits the backing out of taps at any speed with which the machine is provided, regardless of the speed used in driving them in. It is fitted with a friction clutch operated by a lever, the handle of which extends around under the arm, within convenient reach of the operator. The driving mechanism is incased in a box made fast to the base of the machine and consists essentially of a pulley, a cone of seven gears, a ratchet, ratchet gear and operating lever, the shifting of which one notch to another furnishes any one of eight speeds. This box, taken in connection with the back gears on the head, gives the operator a choice of 24 speeds, each of which is instantly available. The machine is furnished as either a half or full universal; each style is made in three sizes, 4, 5 and 6 feet, by the Bickford Drill and Tool Company, Cincinnati, Ohio.

A Large Double Crank Press

The illustration shows a large double crank press. These presses are built for heavy punching, shearing and forming. The crank-shaft is 7½ inches in diameter and has a stroke of 8 inches. The fly-wheel is 60 inches in diameter with an 8-inch face, weighs about 2000 pounds and makes 195 revolutions per minute. The press has a total hight of



A LARGE DOUBLE CRANK PRESS

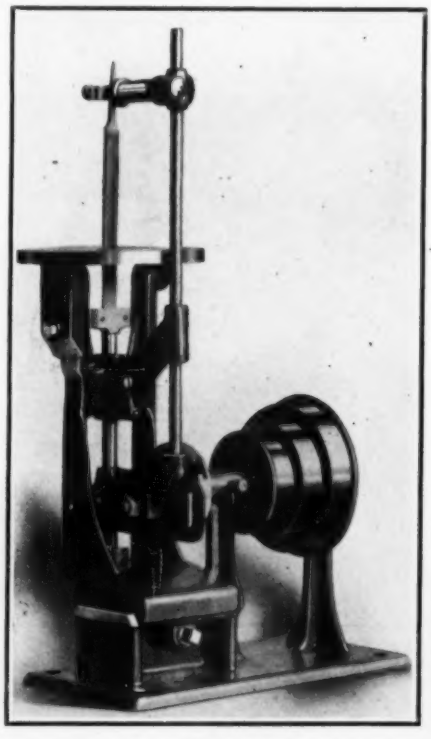
137½ inches with 25½ inches distance between the bed and bottom of the slide. The area of the bed is 24 inches wide by 97 inches long, and the total weight of the press is 47,000 pounds.

The clutch used is the automatic jaw type with positive lock, having three locking points, the faces of which are tool steel and hardened. This clutch is positive in its action and silent when either engaged or disengaged. The pulleys, as shown at *A*, are placed at the back of the press. The bottom knock-outs, at *B* are operated by the slide through the two connecting-rods, the adjustment being by the screws *C C*. The slide has a long bearing in the frame and is adjustable by means of two screws operated simultaneously by level pinions on the shaft *D*.

The press is provided with a safety coupling on the pinion shaft which lets go, avoiding breaking the press body or tools in case of carelessness of the operator in not setting the dies correctly or leaving wrenches, etc., between them. This press is built by the E. W. Bliss Company, 1 Adams street, Brooklyn, New York.

A Bench Filing Machine

The half-tone shows a cataract bench-lathe filing attachment mounted on an independent stand for use as an independent filing machine.



A BENCH FILING MACHINE

The table is 6 inches diameter and can be tilted at an angle; the stroke is 2 inches. It can be used for either filing or sawing. One of the features of this attachment is that it can be used upon a Pratt & Whitney, American Watch Tool Company, or Cataract bench lathe.

This machine is built by Hardinge Brothers, 1034-1036 Lincoln avenue, Chicago, Illinois.

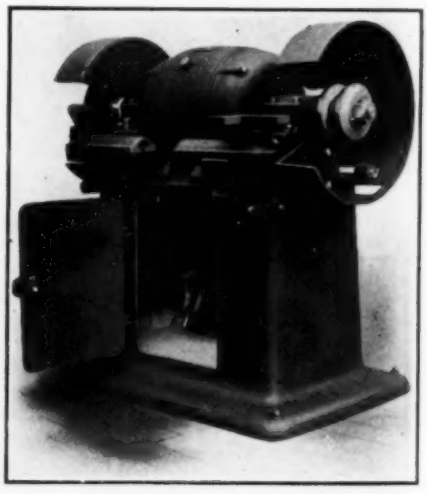
A Speed Controller for Grinders

As grinding wheels wear down, it is necessary to speed up the arbor in order to keep the wheels running at the right peripheral speed so as to obtain the greatest amount of work with the least wear to the wheel.

This has been accomplished in various ways such as the use of cone pulleys, variable-speed motors, etc. These methods have been very unsatisfactory, however, as very few operators will take the time to figure out the proper speed that an emery wheel should run at. They merely increase the speed by guess, with the result that the wheels are run too slow to do their work properly, or so fast they are liable to break, thus endangering life and destroying the wheel.

With the speed controller shown there is no guess-work; the operator knows that the grinding wheels are running at the proper speed to do the most work. A 75 per cent. speed variation is obtained by means of external field control, and a constant peripheral speed is maintained until the wheel is practically worn out. The speed of the grinding wheel is regulated by a gage or roller which is directly under the wheel and which is mounted on a traverse rocker shaft running the length of the machine. As the wheels wear down, these rollers are set so that they touch or nearly touch the wheels. The adjustment of these rollers is accomplished by means of an arm which is connected to the transverse rocker shaft and comes forward, as shown in the cut, and is in easy reach of the operator.

The adjustment of these rollers automatically moves the arm on a field rheostat in the base of the machine, thus cutting the resistance coils one after an



A GRINDER WITH SPEED CONTROLLER

other in and out of the motor circuit, which in turn regulates the speed of the motor for that particular size grinding wheel.

If one wheel wears down faster than the other, the speed is regulated by the larger of the two, as it is impossible to move the roller on one end only, thus preventing the machine being run too fast for the larger wheel.

This speed controller is built by the Ransom Manufacturing Company, Oshkosh, Wis., and can be attached to any of the motor-driven grinders, for direct current, of its manufacture.

New Vertical Milling Machines

The advantages of the vertical-spindle milling machine for a large variety of work are becoming better understood. To meet the requirements of modern practice the new design shown herewith has been brought out by the Brown & Sharpe Manufacturing Company, Providence, R. I., and is known as the No. 3 machine. This means that the longitudinal table feed is 34 inches; cross feed on the knee, 13½ inches; vertical knee feed, 15 inches; and spindle head feed, 8 inches; making a total vertical feed of 23 inches.

These machines are made with either belt or motor drive, as shown in Figs. 1 and 2. With the belt drive the pulley is driven direct from the line shaft unless a countershaft is especially desired; in that case it has but a single pulley of the same size as the one on the machine. This gives a much greater belt contact than is possible with the usual cone drive.

When a motor is used, it is supported on the bracket provided at the back and the pulley is replaced by a sprocket which is driven by silent chain and sprocket on the motor shaft. Any constant-speed motor can be used.

Careful attention has been given to the strength and rigidity of parts to withstand the exacting requirements of the high-speed steel milling cutters now in use, as the unusual speeds and feeds try

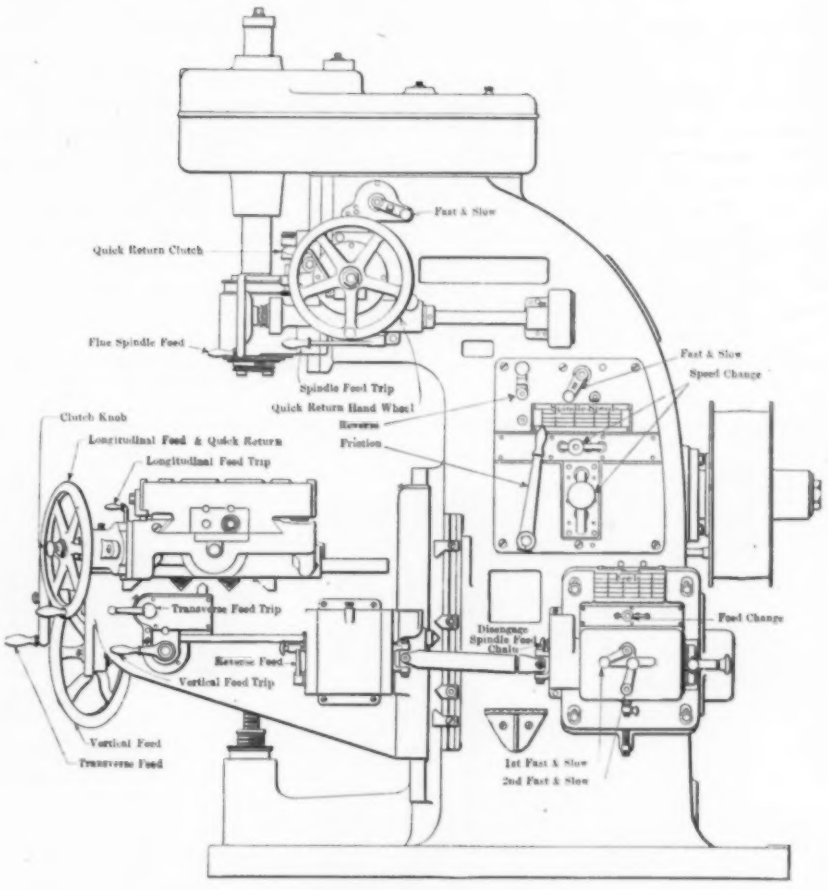


FIG. 3. SHOWING DIFFERENT FEED AND SPEED CHANGES

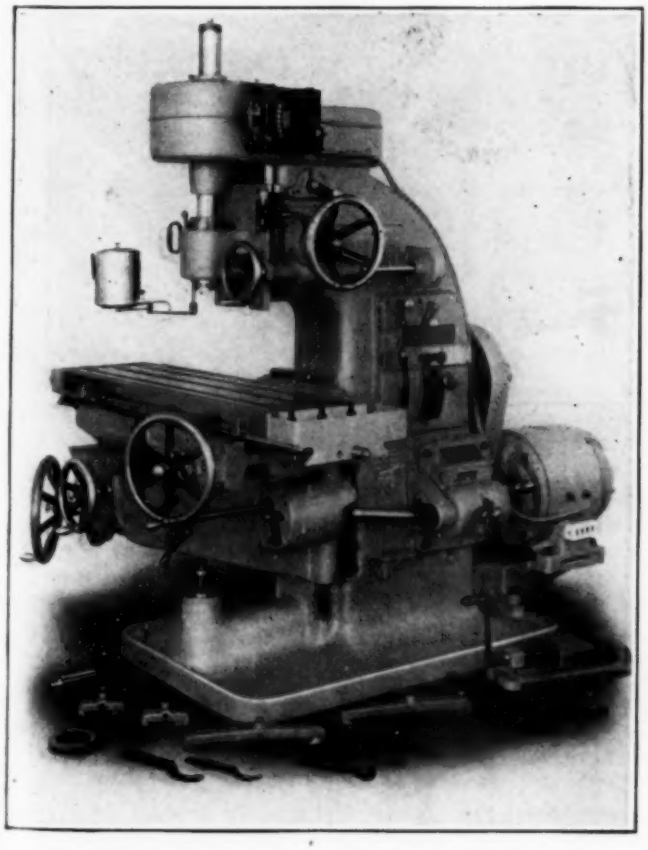


FIG. 1. MOTOR-DRIVEN VERTICAL-SPINDLE MILLING MACHINE

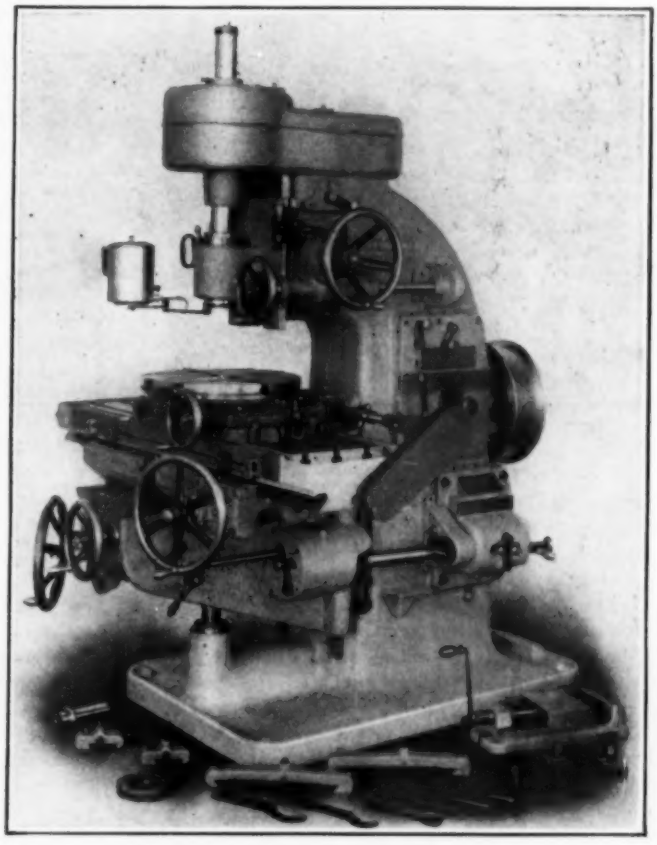


FIG. 2. BELT-DRIVEN MACHINE WITH CIRCULAR MILLING ATTACHMENT

a machine to a greater extent than ever before.

The circular milling attachment in Fig. 2 is a very useful adjunct for a large variety of work and secures all the feeds of the table through the covered chain drive shown at the end. This can be automatically tripped and the circular table fed by the small hand wheel in front.

An idea of the convenience as well as the completeness of speed-changing and feeding devices can be had from Fig. 3, where it will be seen that every controlling lever is within easy reach of the operator at all times and all working parts are inclosed so as to prevent injury.

shown. The changes are obtained by the two pull handles, marked "speed change" in Fig. 3. Then a movement of the small swinging lever throws in a gear and secures the other changes while the small left-hand lever gives the reverse.

In a similar way the feed-change gears are all grouped in the unit *B*, Fig. 4. The index plate shows the feed in inches per minute, which varies from 5/8 inch to 20 inches in practically geometrical progression and seems to cover all the requirements for a machine of this size. Spur gears are used entirely and are driven direct from the machine pulley shaft by chain and sprocket wheels.

is shown at *D*, Fig. 4. In this way all the feed changes of the whole machine are secured in one gear box and transmitted to the various parts.

The table is made heavy and deep to secure the desired stiffness for such a machine as this. There is a large working surface and the T-slots are deep to withstand heavy strain. By adjusting the knob in the center of the hand wheel at right-hand front of the saddle, a quick return and a slow feed can be had with the same wheel. Or the table can be operated from the left if desired. Instead of splining the feed screw, the power is

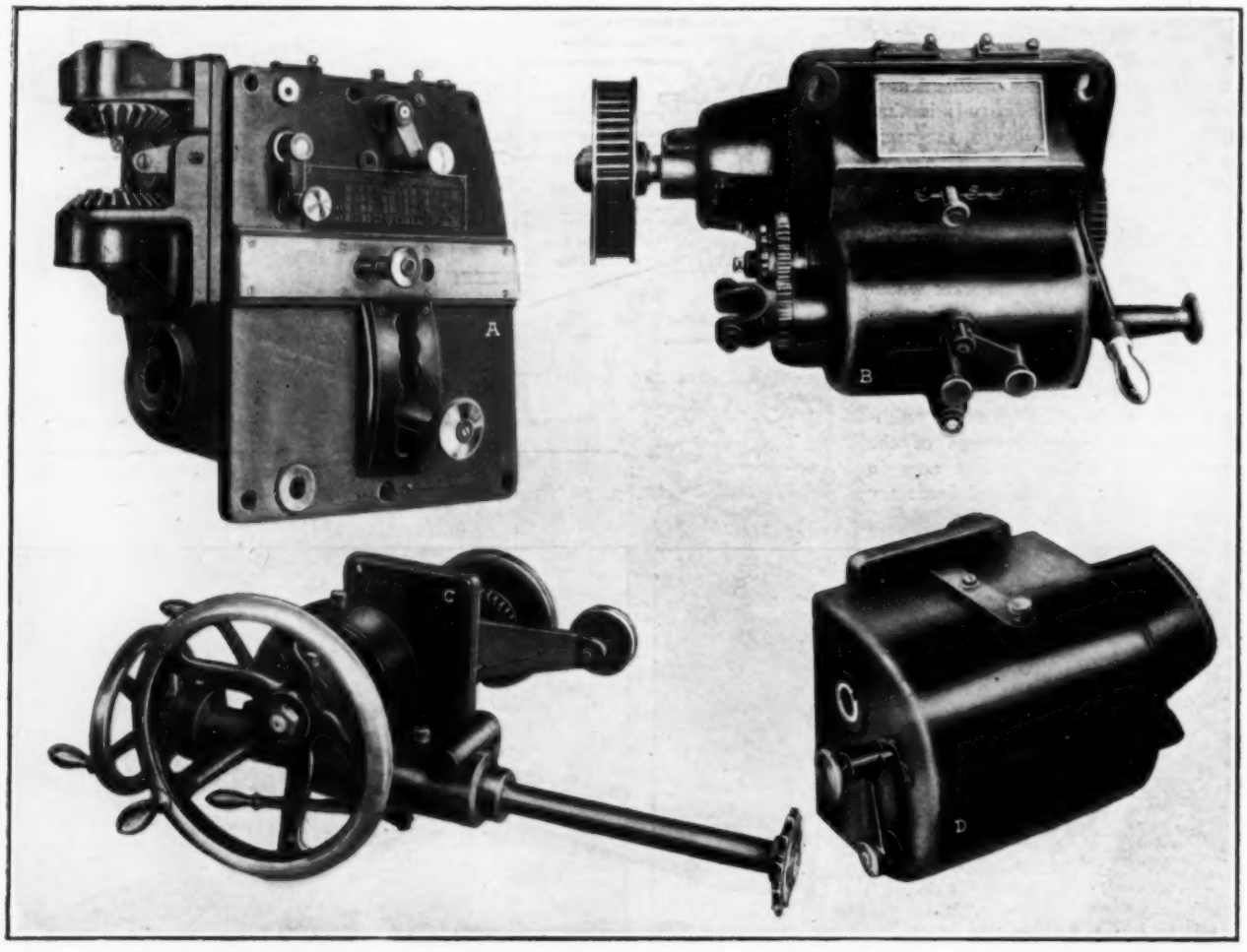


FIG. 4. SPEED AND FEED BOXES

Beginning with the spindle-driving mechanism just at the left of the driving pulley, the whole thing is a unit, as shown at *A*, Fig. 4. Inside the driving pulley or sprocket, as the case may be, is a friction clutch controlled by the lever in the lower left-hand corner, which enables the operator to start or stop the whole machine at will.

This speed box contains a combination of hardened gears, controlled by the four small handles shown and giving various ratios from driving direct to 20 to 1. The index plate shows plainly just what positions of the handles give the speeds

As the pulley shaft runs at a constant speed, it is possible to obtain the correct feeds in inches per minute, independent of the spindle speed. It also gives fixed rate of feed, in inches per minute, for all cutter diameters used by the machine.

The spindle has both hand and power vertical feed, the feeding mechanism being shown at *C*, Fig. 4. The two hand wheels provide for either fast or slow movement as desired. The power feed is by chain and sprocket.

The main feed box drives through the reversing box on the knee to the table feeds by the universal joint. This box

transmitted to the table screw by an auxiliary shaft. This leaves unbroken threads in the feed screw, and both its life and accuracy are correspondingly increased.

The double-plunger type of feed-tripping mechanism is used on the front of the saddle and is very sensitive. It can be set to prevent the wrong clutch being thrown in, which is often very useful. When the feed is tripped automatically, it is not necessary to run the table dog beyond the trip plunger to reverse the feed. A neat device on the front of the saddle has a tripping lever which gives the desired result.

Inquiry for Machinery

(186) Wanted, names of manufacturers of automatic machines for making wire brushes. Address Information Dept. AMERICAN MACHINIST.

Obituary

Thomas Hilton Williams, Sr., of Jersey City, N. J., died at his home at the age of 59. Mr. Williams was president of the A. A. Griffing Iron Company and the C. A. Williams & Son Brass Foundry, both of Jersey City. He was a member of the American Society of Mechanical Engineers and the Engineers' Club.

Personal

E. T. Mathewson, formerly with Standard Machinery Company, of Providence, has resigned and accepted a position with the Waterbury-Farrel Foundry and Machine Company, Waterbury, Conn.

J. W. Bray, associated with the Bullard Machine Tool Company, is now located at 1414 South Penn square, Philadelphia, Penn., in which territory he will look after the interests of his company.

David B. Carse, formerly chairman of the Advisory Committee of the U. S. Steel Corporation, has resigned his position and will take up the business of Carse Brothers Company, which company deals largely in machinery and supplies for railway work.

E. H. Berry, chief engineer of Wyckoff, Seamans & Benedict, Ilion, N. Y., has resigned his position in order to engage in business for himself in New York City. On the occasion of his departure from the Ilion works, Mr. Berry was tendered a banquet by the foremen and assistants and was presented with a diamond stud by his associates.

Business Items

Frederick Peters, Pickhuben 4, Hamburg Germany, has been appointed representative for Diamond Saw and Stamping Works, Buffalo, for the continent of Europe.

The Pittsburg (Penn.) Automatic Vise and Tool Company, has furnished the vise equipment for the large addition which the Carnegie Steel Company has made to its machine shop.

The Northern Electrical Manufacturing Company, Madison, Wis., has established a district office at Pittsburg, Penn., 618 Park building, in charge of C. A. Poe, formerly of C. A. Poe & Brothers.

The J. W. Gore Company, Chattanooga, Tenn., recently organized, has opened quarters at 3 Boyce street, where it carries a full line of machine tools, small tools and metal workers' supplies.

All communications regarding the sale and delivery of the Pinkerton thread milling attachment should be addressed to the Pinkerton Manufacturing Company, 141 Oxford street, Philadelphia, Penn.

Beach-Russ Company, Long Island City, manufacturer of rotary vacuum pumps, pressure blowers and liquid pumps, has just moved into its new brick building, corner West and Green streets, Brooklyn.

The new foundry of R. Hoe & Co., printing press manufacturers, of New York, has been equipped with three 10-ton electric traveling Northern cranes, furnished by the Northern Engineering Works, Detroit, Mich.

The Hisey-Wolf Machine Company, Cincinnati, Ohio, manufacturer of portable electric tools, is moving into its new shops on Township street, Cormany avenue and Canal, which have just been completed. The plant consists of three buildings on a lot 145 feet front by 165 feet deep. The main shop is two stories in hight, with light on four sides. The offices and power plant are in separate buildings.

Trade Catalogs

The Cushman Chuck Company, Hartford, Conn. Catalog and price list of chucks and face-plate jaws. Illustrated, 48 pages, 4x7½ inches, paper.

The Barriett Electric Manufacturing Company, Cincinnati, O. Bulletin No. 1907, illustrating and describing polyphase induction motors. 8 pages, 8x10 inches.

Sprague Electric Company, New York. Bulletin No. 107, illustrating and describing continuous current direct-driven type S generators for lighting and power. 20 pages, 8x10½ inches.

John Royle & Sons, Paterson, N. J. Circular No. 210, "Royle's Book About Saws," which shows a select line of blades for their cabinet and column saw-tables and contains data about the care of saws, etc. Illustrated, 46 pages, 3½x6 inches, paper.

General Electric Company. Schenectady, N. Y. Bulletin No. 4532, describing direct-current motor-starting rheostats, types SA and SO. Illustrated, 4 pages, 8x10½ inches. Bulletin No. 4538, describing catenary line material. Illustrated, 32 pages, 8x10½ inches.

Cutler-Hammer Manufacturing Company, Milwaukee, Wis. Booklet entitled "The Navy Bulletin" containing full descriptions, dimensions diagrams, shipping weights of starting panels, speed regulating panels, machine tool controllers, resistances, etc., to conform to navy yard or shipboard specifications. Illustrated, 48 pages, 5x8 inches paper.

Manufacturers

The plant of the Port Huron (Mich.) Saw Company will be enlarged.

The Sanitary Can Company, Indianapolis, Ind., will erect a $40,000 factory.

The Modern Mining Machinery Company, Portland, Ore., has let contract for a factory.

The Crown Iron Works, Minneapolis, Minn., is making improvements to its plant.

The Great Northern Railroad will erect car repair shops at Superior, Wis., to cost fully $350,000.

The Prims Machinery Company, Battle Creek, Mich., is constructing a new factory and machine shop.

The Sheet and Metal Specialty Company, Follansbee, W. Va., will erect an additional building to its plant.

The Mackie & Lovejoy Company, Chicago, Ill., hardware specialties, will erect a new factory to cost $75,000.

Beach Bros., Charlotte, Mich., manufacturers of steel bridges and culverts, will erect an addition to their plant.

New buildings are being constructed for the Menefee Foundry Company, Fort Wayne, Ind., at a cost of over $10,000.

The Goshen Iron Company, Rich Patch, Va., will rebuild carpenter, machine and blacksmith shop recently burned.

The Tudor Boiler Manufacturing Company, Cincinnati, Ohio, is preparing to make extensive additions to its plant.

The Hammack Steel Range Company, Knoxville, Tenn., has awarded contract for the construction of a new plant.

Sayre Brothers, Phœbus, Va., have incorporated to manufacture castings. Capital $50,000. President S. H. Sayre.

The T. W. Brann Company, Los Angeles, Cal., will erect a new plant for the manufacture of its mining machinery.

The Independence (Va.) Electric and Milling Company will add hub, handle, spoke and other machinery to its plant.

An addition will be erected to the plant of the Williams Bros. Boiler and Manufacturing Company, Minneapolis, Minn.

The William Powell Company, Cincinnati, Ohio, manufacturing steam specialties, has decided to erect a large addition to the plant.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 53 Ann St., New York.

Caliper list free. E.G.Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

Clockwork and clock-operated mechanisms. Larchmont Mfg. Co., Larchmont, N. Y.

Experimental machinery, tools, model work, etc. E. A. Sheldon, New Britain, Conn.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Special machinery and manufacturing plants. Albert Pott, M. E., 23 Platt St., New York.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Contract machine work; tools and dies to order; complete modern equipment. Northwestern Machine Co., Detroit, Mich.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

For Minneapolis and St. Paul territory, manufacturer's agency for any meritorious article or machine, saleable to machine shop trade; we can sell it if it's "right." Roy Machinery Co., Minneapolis, Minn

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACH.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Wanted—High-grade machine work, especially for screw machines and turret lathes. We can refer to a very well known line of high-grade tools now on the market to demonstrate that we are able to do the highest grade of interchangeable work. Box 386, AMERICAN MACHINIST.

Small first-class machine works can acquire sole special manufacture for America of cast-iron self-spanning piston rings for steam and larger gas engines on a novel system; convenient terms; special works in very successful operation in Germany. Write to G. Maack, Cologne, Ehrenfeld, Germany.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we are thoroughly equipped for all classes of machine work, including screw machines and punch parts, tools, jigs, etc.; we design and build special and experimental machinery, also automobiles and marine gasolene engines. Forest City Specialty Manufacturing Co., of Rockford, Ill.

In evenings, invent for profit; might expect mere lawyer to write articles for AMERICAN MACHINIST, as to win saleable patents on machines; no Patent Office Examiner nor other attorney is member both A. S. M. E., and A. I. E. E.; mail invention for free advice, estimate and pamphlet. E. P. Thompson, M. E., Registered Patent Attorney, 53 Morningside Ave., West, or 39 Cortlandt St., New York.

Wanted—An interest in a small or moderate sized machine shop, by a gentleman having a general knowledge of the business and who will have a small amount of machinery of rather high-grade to build; buildings must be of recent construction, detached and having considerable vacant land for future extensions; tools and equipment must be fairly modern; location on some main line of railroad preferred; must be in a good labor market; all communications must be considered confidential by both parties. Box 525, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

COLORADO

Young man now holding for past three years responsible executive position with well known western manufacturer desires to come East; ten years' manufacturing experience; thoroughly understands manufacturing system, manufacturing costs and manufacturing cause and effect, as applied to high-grade machinery; has enviable record as salesman and sales manager, both as to volume and quality of contracts; accustomed to meet and deal with big people; handle and close up big contracts; wants responsible office with established house with remuneration partly by share in profits of business. "D.," Box 486, AMERICAN MACHINIST.

CONNECTICUT

Draftsman and machine designer wants position with firm needing a reliable man with long experience in shop and drafting room and good theoretical knowledge. Box 533, AMERICAN MACHINIST.

INDIANA

Chief engineer experienced in automobile design wishes change; thoroughly up to date and familiar with the most approved practice; has been with two of the largest firms in the country; good references; would accept position as superintendent and designer for small plant. Address Box 549, AM. M.

MASSACHUSETTS

Situation as superintendent or assistant; eighteen years' experience engineering, foundry, machine shop and superintendent's office in large shop. Box 532. AMER. MACH.

MICHIGAN

Draftsman; 28; good all-around man; 7 years' experience mill work, mechanical and electrical; make finest finished drawings if required for patent work; references. Box 554, AMERICAN MACHINIST.

NEW JERSEY

First-class draftsman and designer in direct-acting steam pumps, condensers, air compressors and steam engines desires situation. Box 552, AMERICAN MACHINIST.

General superintendent, 12 years' experience in modern shops, systematizer, successful hustler, at present executive of a large plant, wishes to change. Box 534, AM. M.

NEW YORK

Mechanical draftsman wishes position. Address Box 517, AMERICAN MACHINIST.

Wanted—Position as draftsman; 2 years' experience. Box 537, AMERICAN MACHINIST.

Draftsman and machine designer desires extra work evenings, out or at home. Box 557, AMERICAN MACHINIST.

Draftsman, mechanical, technical graduate, shop experience, designing ability, good detailer, expert tracer; desires to change position; A-1 references. Box 556, AM. MACH.

Draftsman; 36 years; technical graduate; 13 years' drafting, shop; experienced automatic, special, conveying machines, typewriters, jigs, fixture, dies; wishes position. Box 541, AMERICAN MACHINIST.

Engineer of executive ability would like connection with reliable concern as representative or in other capacity; thorough knowledge of machinery, machine tools, engines, etc.; commercial as well as manufacturing experience. Box 560, AMERICAN MACHINIST.

Superintendent or head foreman by technical and a practical man, expert mechanic; designer of special machinery and tools, dies, jigs and fixtures for cheap and accurate production; executive ability and 21 years' experience; open for engagement; 38 years of age; highest references. Box 540, AM. MACH.

RHODE ISLAND

Draftsman of several years' experience wishes position. Box 504, AMER. MACH.

WISCONSIN

Mechanical engineer; designer of cranes, excavators, conveyors, etc., would like to make change after nine years' successful experience. Box 551, AMERICAN MACHINIST.

Wanted—Position as assistant superintendent, foreman, or chief inspector; experienced on engines, machine tools and automobiles; have filled above positions successfully; now employed, but not satisfied; location, anywhere, Middle West preferred. Box 559, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ALABAMA

Wanted—An experienced gin saw maker; permanent position to right man; give age, experience in business and references as to character. Address Continental Gin Co., Birmingham, Ala.

CANADA

Wanted—Foreman for tool room; must be an expert on punches and dies. Apply, stating wages and references to the Canadian General Electric Co., Ltd., Petersboro, Ont., Can.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—First-class automatic screw machine operator; one who understands the Hartford horizontal turret preferred; also man to take charge of a mixed line of hand machines. Address The Standard Mfg. Co., Bridgeport, Conn.

IOWA

Wanted—A man to take charge of a sheet metal department, where die making and deep drawing in steel are specialties; state experience and wages expected. Box 555, AMERICAN MACHINIST.

MARYLAND

Wanted—Two draftsmen on general heavy machinery. Address Ellicott Machine Co., Baltimore, Md.

MASSACHUSETTS

Wanted—Young man with good mechanical and mathematical ability for office position in manufacturing and jobbing business. Box 548, AMERICAN MACHINIST.

Wanted—First-class designer and draftsman for different classes of machinery; must be a good checker, able to take charge of three or four detailers, and also follow the work up in the shop; salary $90 per month; permanent position for the right man. Box 550, AMERICAN MACHINIST.

MICHIGAN

Wanted—Enterprising, energetic, experienced young man to act as assistant general manager in a machine shop. Address "F. S. W.," Station A, Grand Rapids, Mich.

NEW YORK

Wanted—Two first-class wood pattern makers; good wages to the right men. Apply to Clark Bros. Co., Belmont, N. Y.

Toolmaker; A-1 practical mechanic experienced in the manufacture of tools in all its branches and having experience in handling a large force of men; none but a man with such experience need apply; write stating age, experience and salary expected. "H. S. P.," 41 W. 34th St., New York.

Foreman to take charge of machine shop in the vicinity of New York City making hardware specialties and drop forged tools; must have mechanical and executive ability; state previous employment and salaries received; also age and full particulars to "Castings," AMERICAN MACHINIST.

Big Man Wanted—A Company manufacturing strictly high-grade machinery, wishes to get in correspondence with a man capable of taking complete charge of a plant employing 60 to 75 machinists; he must have mechanical and executive ability to establish methods, whereby the machines will be produced in the quickest possible time, at the lowest cost and yet maintain high standards; to the right man, we will make a proposition enabling him to become a stockholder without any cash investment and to draw a fair salary; in answering, give full details of experience, references, present salary, age, etc. Address "Big Man," AMERICAN MACHINIST.

Wanted—In the east a young man having a technical education and at least three years' practical experience in a good machine shop; some experience in selling would be an advantage; must be of good character and habits, straightforward in his dealings and ambitious to establish himself permanently; no application will receive consideration unless by hand written letter giving age, full name and home address, present place of employment, details of school and shop experience; a reasonable salary, permanent position and good prospects for the right man. All communications will be treated with strict confidence. Box 593, AM. MACH.

OHIO

Wanted—Draftsman, experienced on heavy machine tools, particularly boring mills above six feet; give experiences and salary wanted. Box 384, AMERICAN MACHINIST.

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We are increasing our capacity and invite applications from all classes of strictly first-class machinists; steady work, good wages, open shop, nine-hour day; no labor troubles. Riverside Engine Company, Oil City, Pa.

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We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery; good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

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Hill, Clarke & Co., Inc., Boston Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Bartlett, E. E., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving

Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold

Hammacher, Schlemmer & Co. New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines

American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K. Cincinnati, O.
Potter & Johnston Mach. Co. Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Waltcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London. Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe

Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London. Conn.

Chucks, Planer

Bartlett, E. E., Boston, Mass.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split

Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers

Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps

Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.

Clutches, Friction

Caldwell, Son & Co., H. W., Chicago, Ill.

Clutches, Friction—*Cont.*

Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic

Electric Controller & Supply Co., Cleveland, O.

Coal Handling Machinery

Link-Belt Co., Philadelphia, Pa.

Coils

Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring

Adjustable Collet Co., Cleveland, Ohio.

Compound, Pipe Joint

Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air

Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Conduit, Interior

Sprague Electric Co., New York.

Cones, Friction

Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Cambridge, Mass.
Brunswick Refrigerating Co., New Brunswick, N. J.
Seymour & Whitlock, Newark, N. J.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor

Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic

Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.

Cotters—*Continued.*

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery

Veeder Mfg. Co., Hartford, Conn.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Davis Machine Co., W. P., Rochester, N. Y.
Electric Controller & Supply Co., Cleveland, O.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Crane Pullers

Walker, N. U., Boston, Mass.

Cranes

Box & Co., Alfred, Phila., Pa.
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Franklin Portable Crane & Hoist Co., Franklin, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.

Cranes—*Continued.*

Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Lunkenheimer Co., Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Baldwin Steel Co., New York.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co. New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Wks., Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, Ohio.
Fairbanks Co., Springfield, O.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, Ohio.
Kent & Co., Edw. R., Chicago, Ill
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press

Sloan & Chace Mfg. Co., Newark N. J.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford Conn.

Dowel Pins

Winkley Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, O.
Keuffel & Esser Co., New York
Mittineague Paper Co., Mittineague, Mass.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell - Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr. Elec. Co., Inc., Jas., Louisville, Ky.
Independent Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Foote-Burt Co., The, Cleveland, Ohio.

Drilling Machines, Multiple Spindle—*Continued.*

Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co. Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, Ohio.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret

Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co. New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright—*Continued.*

Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Cincinnati Electrical Tool Co. Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.

Drills, Rail

Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Dynamos—*Continued.*

Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York
Sturtevant Co., B. F., Hyde Park Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co. Pittsburg, Pa.

Electrical Supplies

Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances

Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineers, Mechanical and Electrical

Crocker - Wheeler Co., Ampere, N. J.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

Engines, Gas and Gasolene

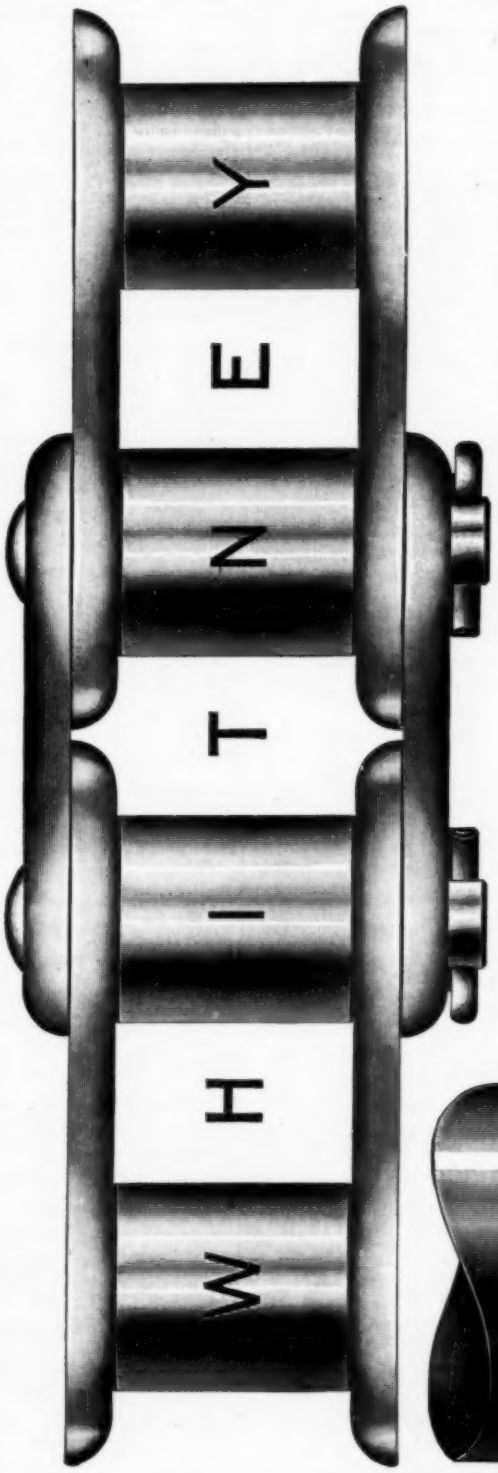
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

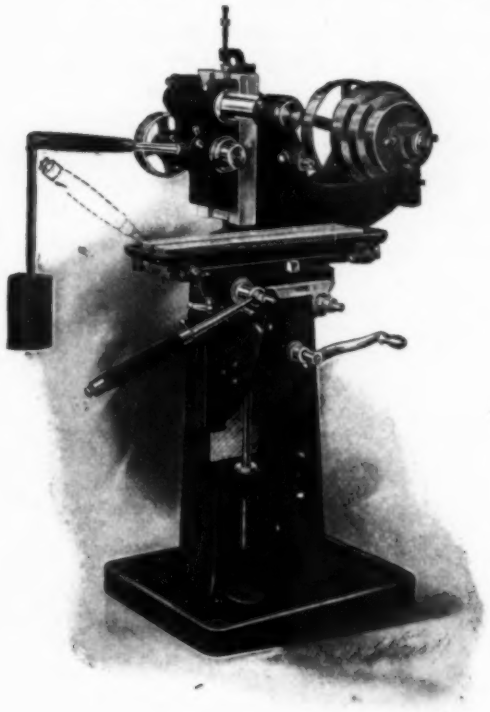
Engines, Motor

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Remington Oil Engine Co., Stamford, Conn.

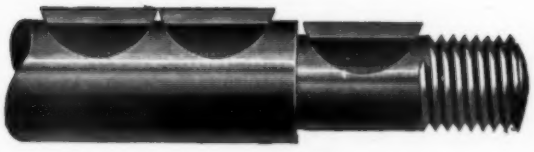
"WHITNEY" CHAINS

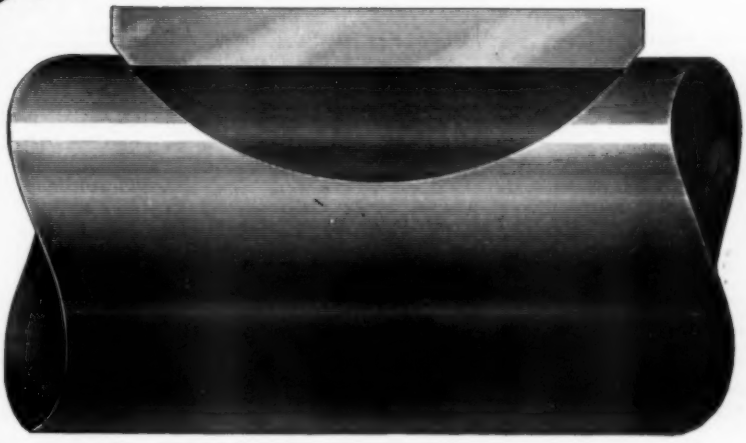
Hand (feed) Milling Machines
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U. S. A.

Engines, Oil
Remington Oil Engine Co., Stamford, Conn.

Engines, Steam
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila., Pa.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment
Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps
American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.

Filler, Iron
Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co, Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Fire Brick
McLeod & Henry Co., Troy, N. Y.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forging Machinery
Scranton Co., The, New Haven, Conn.

Forgings, Drop
Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Brown & Co., R. H., New Haven, Conn.

Forgings, Drop—*Cont.*
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Williams & Co., J. H., Brooklyn, N. Y.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic
Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine
Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel
Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Phila., Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.
Westmacott Gas Furnace Co., Providence, R. I.
Witteman & Co., A. P., Phila., Pa.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach Co., New Britain, Conn.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, Ohio.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.

Gages, Standard—*Continued.*
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam
Crosby Steam Gage & Valve Co., Boston, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.

Gears, Cut
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Carey, Samuel, Glendale, L. I.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Foster Kimball Mach. Co., Elkhart, Ind.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Perkins Mfg. Co., Springfield, Mass.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Carey, Samuel, Glendale, L. I.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets
Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas
American Gas Furnace Co., New York.

Gibs
Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Center
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Eletcrical Tool Co., Cin., O.

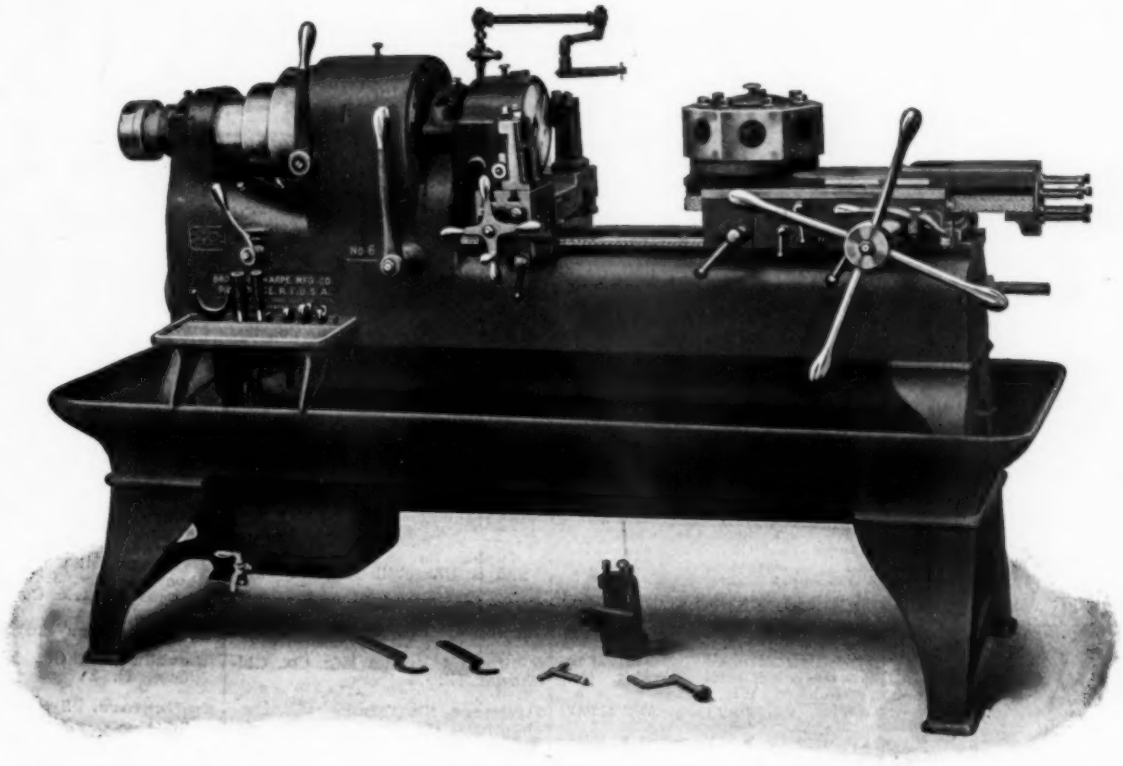
Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Crocker-Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.

BROWN & SHARPE MFG. CO.,

PROVIDENCE, R. I., U. S. A.

NO. 6 WIRE FEED SCREW MACHINE



Capacity: Hole through spindle, 1⅝". Length that can be turned, 10". Swings over bed, 18": over cross slide, 8¾". Roller Feed.

For work within its Capacity, its Accuracy is sure.

A FACTOR of prime importance insisted upon in the manufacture of B. & S. Screw Machines is QUALITY OF WORKMANSHIP as absolutely essential to the best results. Accuracy is established by such emphasis and no detail where alignment is required is overlooked. The testing of each machine before it leaves the shop is of such rigid character that Accuracy is positively insured.

A circular of this machine, describing it in detail, sent to any address upon application.

Grinders, Cutter—*Continued.*
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Taylor & Fenn Co., Hartford, Ct.

Grinders, Drill
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Independent Pneumatic Tool Co., Chicago, Ill.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw
Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Mummert, Wolf & Dixon Co., Hanover, Pa.

Grinders, Tool—*Continued.*
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cin., O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machinery
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Machry. Co., Cleveland, O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Gardner Mach. Co., Beloit, Mich.
Goodell - Pratt Co., Greenfield, Mass.
Graham Mfg. Co., Providence, R.I.
Greenfield Mach. Co., Greenfield, Mass.
Harding, S. B., Waukesha, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Wells Sons Co., F. E., Greenfield, Mass.

Grinding Wheels
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co, Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames
Athol Machine Co., Athol, Mass.
Cleveland Stone Co., The, Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.

Gun Barrel Machinery
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Clayton Air Compressor Works, New York.
Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., The, New Haven, Conn.

Hammers, Steam
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting
Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.

Hoisting and Conveying Machinery
Box & Co., Alfred, Phila., Pa.
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Moore Co., Franklin, Winsted, Ct.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
United Engineering & Fdry. Co., Pittsburg, Pa.
Yale & Towne Mfg. Co., New York.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker - Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Chicago Flexible Shaft Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hones
Chicago Pneumatic Tool Co., Chicago, Ill.
Pike Mfg. Co., Pike, N. H.

Hose
Chicago Pneumatic Tool Co., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Rhoads & Son, J. E., Phila., Pa.
Sprague Electric Co., New York.

Igniters, Gas Engine
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Indicators, Speed, Peripheral
Warner Instrument Co., Beloit, Wis.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co. Boston, Mass.

Indicators, Test
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Norton Grinding Co., Worcester, Mass.
Starrett Co., L. S., Athol, Mass.

Injectors
Desmond-Stephan Mfg. Co., Urbana, O.
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Inspection and Tests
Hunt Co., Robert W., Chicago, Ill.

Instruments, Electric
General Electric Co., New York.

Iron Bar
Milton Mfg. Co., Milton, Pa.

Jacks, Hydraulic
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Burroughs Co., Chas., Newark N. J.
Watson-Stillman Co., New York.

Jacks, Planer
Armstrong Bros. Tool Co., Chicago, Ill.